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THE ANTHROPOMETRY OF THE WESTERN AND COPPER ESKIMOS, BASED ON DATA OF VILHJALMUR STEFANSSON

BY CARL C. SELTZER

Peabody Museum, Harvard University

WITH AN INTRODUCTION BY VILHJALMUR STEFANSSON

INTRODUCTION

The request of Dr. Carl C. Seltzer that I write an introduction for his paper, "The Anthropometry of the Western and Copper Eskimos," gives an opportunity for more or less reviewing it in advance of publication. This I do in part by reviving the hazy memories of twenty-five years ago, and then gossiping in a way that may be slightly useful to students of his work.

The anthropometric notions and tools which I carried with me into the field in 1906, when I started gathering the figures that are behind Seltzer's study, were those favored by Dr. W. C. Farrabee who was then instructor in physical anthropology at Harvard. My ethnological horizon had been largely determined by the courses that were being given by Roland B. Dixon, then instructor and now professor. The glamor of the subject and the enthusiasm with which I tackled the job of field anthropology were in no small part the result of association with Frederick Ward Putnam, the head of our department. In 1903, as a student of comparative religions in the Divinity School, I had elected a beginner's course in anthropology. After that for two years I was in the department of anthropology first as the holder of a fellowship and later as a fellow and assistant instructor.

The point of saying all this here is that when I started my work among the Eskimos of the Mackenzie Delta I searched for the things which my training had led me to consider important, and used methods, among them the physical-anthropological, in which I had been instructed at the Peabody Museum of Harvard University. The instruments I used were a loan from the Museum.

I knew from conversation with Professor Franz Boas and from his pamphlet entitled "A. J. Stone's Measurements of the Natives of the Northwest Territories" that I had had in the Mackenzie region a predecessor who measured heads and statures. Knowing this was a piece of good luck. Obviously I might discover a

few of the same individuals and then I could check my measurements against Stone's to give some idea of accuracy. I did ask the people around Fort Macpherson and found some whom he had measured. On these I could not get quite his results but that had little bearing on the rest of my work—I don't suppose the differences between us in figures were any greater than you would expect from different observers. What proved important was that I found (either then or later, chiefly later) that some of the people whom he lumped together as Nunatagmiut came from districts far removed from others whom he also called Nunatagmiut. Presumably they could not be in reality very near in blood if they were far in miles and separated from each other by peoples whom they at least consider not of their own kind. Stone had just measured together those whom the whalers and traders spoke of by the same name.

I could not remove from my measurements that personal equation which had made them differ from Stone's, but I could profit in other ways from our differing circumstances. He had been a transient concerned with other business while I was, or intended to be, an anthropologist by profession and was planning to spend years at the work. I could and would make detailed inquiries as to blood ancestry, instead of bunching individuals together according to a traders' custom.

With this for my cue, I typically discovered that while a man's father was born at, say, Cape Smythe, his father had been looked upon as a member of the Oturak people, his mother, however, being from Point Hope. Still I found later that the meticulousness about fathers had problematic weight for (except as they had just recently acquired the information from whites) these Eskimos had not looked upon fatherhood at all as we do—every conception was to them miraculous and the father is merely the person to whom the mother was, according to their view married. For instance, I discovered eventually that in cases where a woman's husband died during her pregnancy the next husband was always considered the father of the child.

What I did, then, as a rule, was to trace the ancestry as carefully as possible to include all four grandparents; while in some cases, as for instance when an ancestor was known to be a non-Eskimo (say an Athabasca Indian), I would take records farther back than the grandparents.

The scope of Seltzer's studies has been such, however, that he has made no great use of these in many cases elaborate genealogical notes except to determine the group in which an individual was to be placed. Naturally, having put so much work on it, I am hoping that a later study can be published which will make some use of this relationship material.

The geographic classifications used in my diaries and by Seltzer in this study are those of the Eskimos themselves, although we have not always gone into it quite as narrowly as they do. To take a case from home: Eskimos might distinguish between Bronx, Brooklyn, Manhattan and Queens, but that and more Seltzer lumps under New York.

Nearly always among Eskimos there is some dialectic variation to go with geographic distinctions. For instance, there were probably seldom five years when an ordinary member of the Noatak group did not see and speak to more than half of the Kuwuk group; yet, even so, a Killirk native would tell you decisively after hearing a few words, "This man is from Noatak, that one from Kuwuk."

In many cases you would expect physical differences even when people were as nearly related by blood and geography as those of Noatak and Kuwuk—for one thing, the Kuwugmiut had more histories of intermarriage with the Athabasca Indians of the Lower Yukon; from that (pending evidence to the contrary) you expect some difference of physical type.

In general the Eskimos of northwest Alaska would agree with Seltzer in his way of affiliating certain peoples with others. I think they would disagree in one case only—where he puts the Oturkagmiut into the group that contains Point Barrow and Cape Smythe. In their own opinion and that of their neighbors the Oturkagmiut are more nearly related to the group which includes the Noatak. However there is undeniably a great deal of intermarriage between the Oturkagmiut inlanders and the coastal people; for, of all the inlanders, the Oturkagmiut descended most frequently to the coast and stayed the longest. So the Seltzer grouping may not be far astray after all.

The same question arises with more abstruse surroundings when Seltzer divides those Copper Eskimos for whom I furnished him measurements into (1) Victoria Island, and (2) Coronation Gulf. If you have no information before you except the map, this division is unassailable. Even when you know the facts, or at least those of them that I know, you are puzzled how to find a better division—but you are a good deal worried, as may appear hereafter.

At least two of the southwest Victoria Island groups, those of Puivlirk and Noahonirk were in my time (especially at my first visit, 1910-11) in very close relation with the mainland group of Akuliakattak. However these two, but not the Akuliakattagmiut, were in close relations by intermarriage with the people to the north, those of Prince Albert Sound and Minto Inlet.

But the really significant and disturbing thing is that the Prince Albert and Minto people were travelers beyond anything known to me from the whole Eskimo world.[1] They apparently enjoyed traveling but apart from that they had to have, or thought they had to have, wood of a quality beyond their local drift. Some of this they got by trade from, say, the Puivlirmiut who either fetched it themselves from the Bear Lake forest or else secured it by trade from perhaps the Kogluktogmiut.[2] But more than half of it they got from three or four times as far away, by first journeying east or southeast across Victoria Island and then crossing Dease Straits to the mainland and going all the way to the Baker Lake district and even farther down towards Chesterfield Inlet where they chopped down their own trees, picked up drift, or bought choice pieces from Eskimos whom they met.

Summing it up briefly, the most northerly Eskimos of Victoria Island were more likely to intermarry with mainland people far to the south and east than with the people around the mouth of the Coppermine who in miles were only a quarter of the distance away. The people of *eastern* Coronation Gulf (very few of whom

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[1] See Stefansson, 1913, p. 284 ff; 1914, p. 28, 36, 37; 1921, p. 419; cf. David T. Hanbury, "Sport and Travel in the Northland of Canada" p. 14 (*London*, 1904) and various references to travel in D. Jenness "The Copper Eskimos" (*Ottawa*, 1923).

[2] Anyone interested in a more elaborate division of these Eskimos than that used by Seltzer will find it on the maps in Stefansson's "My Life with the Eskimo," 1913, (or, better, the abridged edition of 1929) and in Jenness' "The Copper Eskimos," 1923.

I had a chance to measure although Jenness measured a good many of them) mixed to a considerable extent with the same remote people whom the northern Victoria Islanders used to meet near Baker Lake, but those of *western* Coronation Gulf were practically cut off from this chance of intermingling—except, of course, indirectly by western and eastern Gulf people marrying each other.

It is, therefore, not as surprising as it looks on the map to find resemblances between the northern Victoria Islanders and groups far away to the southeast.

For students of the Seltzer tables it may be worth keeping in mind that, while head length among Eskimos is about as easy to measure with women as with men, there is in some districts a special difficulty in securing the breadth of head of the women; for in certain localities in my time they wore their hair so that a tight twist of it came above the ears. I remember this difficulty particularly for Mackenzie River.

Students of the physical anthropology of the Eskimos should have special reservations in their minds, I feel, when they compare Greenland and Labrador with other districts. For the mixing of aboriginal blood with European began in Greenland shortly after Eric the Red, 982, and in Labrador shortly after Cabot, 1497. It may even have begun much earlier than that in Labrador in connection with the voyages which the European Greenland colony made to secure timber, even if you do not regard what many Newfoundland historians believe, that there were fifteenth century European fishermen on the Banks and along the Labrador coast before Cabot.

Authorities who twenty years ago estimated a maximum European population in West Greenland during the Middle Ages at 3,000 have now raised it to 10,000, and the belief that this colony was exterminated by disease, war, or any other combination of causes is rapidly giving way before the view that they amalgamated with the natives, the culture disappearing but not the blood. Reduce by half the estimated European component and you still have the probability that at the time of Cabot there was as much white as Eskimo blood in the so-called Eskimos of West Greenland. The percentage has increased since then, so that it is only from Smith Sound and East Greenland that you have people whom you can reasonably compare *as Eskimos* with, say, Mackenzie River or Point Barrow.

Perhaps the least interesting part of the current Seltzer paper is, then, where he follows the custom of writers on Eskimo physical characters in treating West Greenlanders and Labradoreans as if they were largely if not wholly Eskimo in blood. That I think so will be no news to him when he sees this introduction, nor does he probably disagree, for (although he does not mention it in the body of his paper) he has been working for years on material that is likely to throw considerable light on blood mixture problems in Greenland. For there is in the Peabody Museum at Harvard a collection of more than eighty skulls with a good many other bones of people who were living in Iceland at the time when the race mixture was going on in Greenland—from the eleventh to the fifteenth century. The mediaeval Europeans in Greenland practically all came from Iceland and most of them from that part of Iceland (the west coast) from which the Peabody collection is derived. It was, then, Europeans of that type who combined with Eskimos (which presumably up to this time had no European admixture) to form by their amalgamation the Greenlanders of the post-Columbian period.

There is a growing body of evidence to show that Englishmen and perhaps Hollanders traded in Greenland just before Columbus, but it does not seem likely that the "Eskimos" gained any large percentage of European blood from that source. There should be keen interest, therefore, in the Greenland angle of Seltzer's forthcoming paper on "The Physical Anthropology of the Mediaeval Icelanders."

The preparation of both the present study and that on the Mediaeval Icelanders was made possible through the interest taken by the Russell Sage Institute of Pathology of New York and the Institute of American Meat Packers of Chicago in the bodily characteristics of a meat-eating people. At the urging of Dr. Raymond Pearl, of Johns Hopkins, and Dr. Clarence W. Lieb, of 400 Madison Avenue, New York, the Packers voted a considerable grant to a committee of distinguished scientists under the chairmanship of Dr. Pearl. Although the larger part of this money was used by the Russell Sage Institute of Pathology for research on subjects who were living on exclusive meat diet, there was some left over that could be given to Professor E. A. Hooton, of the Peabody Museum of Harvard University, for the study of the skeletal remains of meat eaters and for such work as that which Seltzer has done on the physical measurements of recent Eskimos.

Since I had to do with collecting both the Eskimo measurements and the Icelandic skeletal material it is my place to thank both the Russell Sage Institute of Pathology and the Institute of American Meat Packers for the broad interpretation of their research problem which enabled us to include the Seltzer studies. Not less should I, and whoever is interested in such problems, thank Professor Hooton for that continued and enthusiastic support of the project which enabled us to interest the Packers in giving the money and Seltzer in doing the work. Seltzer's own reward will be in the appreciation of those of us who have been associated with him and in the satisfaction of having contributed substantially to a field hitherto little cultivated, that of the physical anthropology of the Western and Copper Eskimos.

VILHJALMUR STEFANSSON.

THE DATA

Vilhjalmur Stefansson made three polar expeditions. He made his first trip as ethnologist of the Leffingwell-Mikkelsen Arctic Expedition 1906-07,[3] the second in 1908-12 as leader of the Stefansson-Anderson Expedition,[4] the third as Commander of the Canadian Arctic Expedition 1913-18.[5] It was during the first two trips that he was able to take anthropometric measurements on the various Eskimo groups he encountered. The first expedition of 1906-07 was spent mainly among the Eskimos of the Mackenzie delta, although he went as far west as the Colville; on the second visit, 1908-12, Stefansson travelled as far west as Kotzebue Sound and as far east as the Coronation Gulf.

[3] Stefansson, 1922.
[4] Stefansson, 1913, 1914.
[5] Stefansson, 1921.

Although the measurements taken on each individual were few in number (this being nevertheless the largest series of its kind), because of their broad geographical scope and racially uncontaminated character I feel fortunate, as other students of Eskimo anthropology will agree, to be able to extract and present this valuable material from Stefansson's voluminous diaries.

Measurements Recorded and Indices Calculated

Measurements were taken on adult males and females (18-60 years of age) and on sub-adult males and females (3-17 years of age) as follows:

Head length (maximum glabello-occipital length)
Head breadth (maximum biparietal breadth)
Face height (menton-nasion height)[6]
Face breadth (maximum bizygomatic diameter)
Stature
Sitting height (sitting height to vertex)

From the above measurements the following indices were calculated:

Cephalic index (ratio of head breadth to head length)
Facial index (ratio of face height to face breadth)
Cephalo-facial index (ratio of face breadth to head breadth)
Relative sitting height (ratio of sitting height to stature)

Nature of the Material

This may be stated without reservation, that there is no Arctic explorer who has been as intimate with the Eskimos of Alaska, and western and central Canada, as Stefansson. He lived their life, ate their food, built their dwellings, spoke their language, and simulated the Eskimo mode of living as closely as possible. The inevitable result was that he soon stood on amicable footing with all those whom he encountered and was easily able to ascertain their tribal and racial affiliations.

These facts have an important bearing upon this study in that every Eskimo included in this paper is without reasonable doubt a pure-blooded Eskimo. Besides, these measurements were taken between 1906

[6] Stefansson measured face height from glabella to menton, but a correction has been applied to make face height read from nasion to menton. For correction see Connolly, 1926.

and 1912 when white blood mixture, except in the Barrow region, was just beginning. The parentage of every half-blood child was known and only one of them was as yet old enough to be married.

Division of the Material

As stated above, measurements were taken on various groups of Eskimos from Kotzebue Sound as far east as Coronation Gulf. It would be futile and profitless to attempt a survey of each tribe separately inasmuch as certain tribes obviously belong together, due to their blood affiliations and constant contact with each other. Therefore, Stefansson, on the basis of his knowledge of their relationships, has divided them into the following groups.

(1) *Kotzebue Sound.* Includes all those groups on the Alaskan coast from Cape Prince of Wales to and including Point Hope.

(2) *Barrow.* Includes all those groups along the coast north of Point Hope district to and including the region around Point Barrow.

(3) *Nunatagmiut.* Includes all the groups residing along the Colville Basin, as the Nunatagmiut proper, the Noatagmiut, etc.; also the Eskimos on the mid-eastern Alaskan coast near or at the delta of the Colville River.

(4) *Mackenzie.* Includes all tribes along the northern Canadian coast in the region of the Mackenzie delta from Herschel Island east to Cape Parry.

(5) *Victoria Island.* Includes the Prince Albert Sound people and the Haneragmiut on southwestern Victoria Island.

(6) *Coronation Gulf.* Includes all tribes living in and around Coronation Gulf.

Kotzebue Sound Eskimos

This group consists of 30 adult males and 8 adult females who are members of tribes along Kotzebue Sound from Cape Prince of Wales to Point Hope. The following tribes are represented in this division, Kivalina, Selawik, Tapkak, Kangianik, Kittegarmiut, Kigirktaruk, Port Clarence, Cape York, and Cape Prince of Wales.

Barrow Eskimos

All the individuals in this classification belong to the tribes that reside along the Alaskan coast from Icy Cape to Point Barrow. Here

DISTRIBUTION OF ESKIMO GROUPS
BARROW
KOTZEBUE
NUNATAGMIUT
MACKENZIE
CORONATION GULF
VICTORIA ISLAND
VICTORIA
ISLAND
Horton River
Mackenzie River
Yukon River
Pt Barrow

were measured 85 adult males and 28 adult females. The tribes in this district are the Kugmiut, Nuvugmiut, Utkiavigmiut, Oturkagmiut,[7] etc. These people live mainly at Point Barrow, Cape Smythe, Wainwright and Smith Bay. The Oturkagmiut are considered to live inland from Icy Cape.

Nunatagmiut Eskimos

The Nunatagmiut group contains 72 adult males and 55 adult females. This includes most of the tribes living in the Colville valley, along the Colville River and tributaries and at Colville delta. The tribes are the Nunatagmiut proper, Noatagmiut, Kuvugmiut, Kangianirmiut, Killirmiut, Kagmallirmiut. These people were measured chiefly on or near the Colville, at Barrow (Cape Smythe) and Point Barrow when they came down to the coast for the whaling season, and at Herschel Island in the east where they journeyed to meet the whaling vessels in order to obtain supplies and employment on the ships.

Mackenzie Eskimos

The Mackenzie Eskimos extend along the mouth and delta of the Mackenzie River from Herschel Island to Cape Parry. Here Stefansson measured 48 adult males and 40 adult females at Stokes Point, Baillie Islands, Kangianik, Booth Islands, Tuktuyaktok and Imnaluk belonging to the Kupugmiut, Kittegaryumiut, Kigirktagmiut, and Avvagmiut tribes.

Victoria Island Eskimos

The Victoria Islanders in this series are those tribes that occupy the southwestern end of Victoria Island and include the Kanghiryutsiagmiut around Minto Inlet, the Kanghiryuarmiut who inhabit Prince Albert Sound, and the Haneragmiut[8] who live near Cape Kendall, southeast of Ikpigyuak Cape. This group consists of 30 adult males and 19 adult females.

Coronation Gulf Eskimos

During 1910-11 Stefansson measured 65 adult males and 46 adult females affiliated with the Akuliakuttagmiut, Puiplirmiut, Noahonirmiut,

[7] The Oturkagmiut have been included in the Barrow group because although they have some Nunatagmiut blood, those measured by Stefansson show closer affiliations with the coastal peoples.

[8] The Haneragmiut are known to have mixed a good deal with the Coronation Gulf Eskimos.

Pallirmiut, Kogluktogmiut, Nagyuktogmiut, and Utkusiksaligmiut tribes. This group was studied again a few years later by Jenness whose report may be found in the reports of the Canadian Arctic Expedition 1913-18.

PRESENTATION OF MATERIAL

TABLE 1

Head Length

	NO.	RANGE	S. D.	MEAN	C. V.*
Males:					
Kotzebue Sound ..	30	185-211	192.50 ± 0.72	5.83 ± 0.51	3.03 ± 0.26
Barrow	62	179-210	192.39 ± 0.54	6.39 ± 0.38	3.32 ± 0.20
Nunatagmiut	64	180-199	190.03 ± 0.40	4.78 ± 0.28	2.52 ± 0.15
Mackenzie	47	185-212	196.26 ± 0.56	5.71 ± 0.40	2.91 ± 0.20
Victoria Island ...	30	185-206	194.13 ± 0.58	4.73 ± 0.41	2.44 ± 0.21
Coronation Gulf ..	65	182-211	195.71 ± 0.47	5.58 ± 0.33	2.85 ± 0.17
Females:					
Kotzebue Sound ..	8	183-189	185.00 ± 0.45	1.87 ± 0.33	1.01 ± 0.17
Barrow	26	176-194	184.88 ± 0.61	4.65 ± 0.43	2.52 ± 0.24
Nunatagmiut	55	173-197	182.91 ± 0.43	4.72 ± 0.30	2.58 ± 0.17
Mackenzie	40	178-198	186.90 ± 0.60	5.58 ± 0.42	2.99 ± 0.23
Victoria Island ...	19	172-200	186.74 ± 1.06	6.82 ± 0.75	3.65 ± 0.40
Coronation Gulf ..	46	179-201	188.70 ± 0.47	4.72 ± 0.33	2.50 ± 0.18

* The probable errors of the means, standard deviations and coefficients of variation, have been calculated with the aid of Pearson's tables of χ_1 and χ_2. See Pearson, 1914.

Table 1 contains the mean head lengths of the males and females of our Eskimo groups. The most striking feature among the males is the remarkable length of the heads of the Mackenzie Eskimos, who have a mean diameter of 196.26 mm. The Coronation Gulf group shows the next longest head length, while the Nunatagmiut have the shortest of all, 190.03 mm., a fact which no doubt betrays some mixture in modern and in recent prehistoric time with the Athapaskans to the south. The Kotzebue Sound and Barrow males have mean head lengths that are very similar. Another interesting point is that the more isolated and northern Victoria Islanders, who are geographically farther away from

TABLE 2

Comparative Table of Mean Head Length

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
East Greenland	Hansen (1893)	..	192.0	..	187.0
Angmassalik (E. Greenland)	Poulsen (1909)	26	192.27	10	183.50
Smith Sound	Steensby (1910)	8	196.25	10	187.6
Labrador	Pittard (1901)	8	195.00	6	192.66
Labrador	Duckworth and Pain (1900)	11	191.15	10	190.25
Labrador	Virchow (1880)	3	197.3	2	190.5
Baffin Island	Oetteking (1931)	10	197.6	13	190.4
Southampton Island	Tocher (1902)	35	192.4	..	.....
Hudson Bay	Birket-Smith (1925)	99	193.7	..	.....
Coronation Gulf	Author	65	195.71	46	188.70
Coronation Gulf	Jenness (1923)	82	195.9	42	190.0
Victoria Island	Author	30	194.13	19	186.74
Mackenzie	Author	47	196.26	40	186.90
Mackenzie	Jenness (1923)	4	196.8	..	.....
Mackenzie (Koupagmiut)	Boas (1901)	12	195.2	6	187.8
Nunatagmiut	Author	64	190.03	55	182.91
Nunatagmiut	Boas (1901)*	11	189.0	5	181.0
Barrow	Author	62	192.39	26	184.88
Point Hope	Jenness (1923)	13	192.8	..	.....
Kotzebue Sound	Author	30	192.50	8	185.00
Seward Peninsula	Shapiro (1931)	40	195.3	..	.....
St. Lawrence Island	Hrdlička (1930)	63	193.3	48	185.6
Southwest Alaska	Hrdlička (1930)	61	192.9	24	188.5
Asiatic Eskimo	Jochelson-Brodsky (1906)	60	189.8	80	184.5

* *Note by Stefansson:* At the time of the Stone-Boas measurements the word "Noonatama," as used near the Mackenzie where Stone did measuring, meant: Any Eskimo from the American mainland farther west than Herschel Island. A Stone-Boas Nunatagmiut might therefore belong to any of a dozen Seltzer "tribes"—to any of his divisions west of Herschel. Most of these were probably from Port Clarence, Cape Prince of Wales, or from the Kuvuk and Noatak rivers.

possible Indian admixture show shorter mean head lengths than their southern Coronation Gulf neighbors.[9]

Among the females, although the Mackenzie have fairly long heads, they are exceeded in this character by the Coronation Gulf women. The Victoria Islanders again have a shorter mean head length than the Coronation Gulf group. The Nunatagmiut females, as expected, exhibit the shortest mean head length of 182.91 mm., while the Barrow and Kotzebue Sound women are similar to each other as are the men.

The Mackenzie males in this feature too, differ markedly from any of the other Eskimo groups, having the narrowest mean head breadth of 146.68 mm. The mean next in size is that of the Coronation Gulfers which is 4.41 mm. wider. The Nunatagmiut again show their Athapaskan taint in having the broadest heads with a mean of 154.48 mm. The Kotzebue Sound and Barrow males are similar in head breadth as

TABLE 3

Head Breadth

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	137-168	151.60 ± 0.77	6.24 ± 0.54	4.12 ± 0.36
Barrow	62	136-166	151.11 ± 0.49	5.71 ± 0.35	3.78 ± 0.23
Nunatagmiut	64	139-163	154.48 ± 0.39	4.57 ± 0.27	2.96 ± 0.18
Mackenzie	47	138-157	146.68 ± 0.41	4.19 ± 0.29	2.86 ± 0.20
Victoria Island ...	30	143-160	151.83 ± 0.48	3.87 ± 0.34	2.55 ± 0.22
Coronation Gulf ..	65	142-160	151.09 ± 0.36	4.32 ± 0.26	2.86 ± 0.17
Females:					
Kotzebue Sound ..	8	133-146	142.50 ± 0.92	3.84 ± 0.65	2.69 ± 0.45
Barrow	26	138-153	144.54 ± 0.51	3.87 ± 0.36	2.68 ± 0.25
Nunatagmiut	55	138-156	148.46 ± 0.39	4.31 ± 0.28	2.90 ± 0.19
Mackenzie	40	131-153	140.90 ± 0.37	4.49 ± 0.34	3.19 ± 0.24
Victoria Island ...	19	135-152	145.37 ± 0.69	4.44 ± 0.49	3.05 ± 0.33
Coronation Gulf ..	46	135-153	143.87 ± 0.40	4.05 ± 0.28	2.82 ± 0.20

[9] *Note by Stefansson:* It is chiefly on an uninterpreted map that the more northerly people seem more isolated. The reports of Hanbury, Stefansson and Jenness (taken in chronological order) show that the more northerly Victoria Islanders made frequent journeys to the Baker Lake and Chesterfield Inlet district and had opportunity of blood mixing with the southerly and southeasterly groups from Kent Peninsula to Hudson Bay. (Hanbury, David T. Sport and Travel in the Northland of Canada, p. 14. For evidence as to what Eskimos Hanbury met, see Stefansson, 1913, p. 285; Stefansson, 1914, pp. 28, 36, 37; Stefansson, 1921, p. 419. See also Jenness, 1923, p. 48.)

TABLE 4

Comparative Table of Mean Head Breadth

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
East Greenland	Hansen	..	147.0	..	141.0
Angmassalik (E. Greenland)	Poulsen	26	147.08	10	139.90
Smith Sound	Steensby	8	152.75	10	144.90
Labrador	Pittard	8	148.37	6	144.17
Labrador	Duckworth and Pain	11	147.65	10	141.80
Labrador	Virchow	3	149.0	2	137.0
Baffin Island	Oetteking	10	150.1	13	147.9
Southampton Island	Tocher	35	148.5	..	.....
Hudson Bay	Birket-Smith	99	149.7	..	.....
Coronation Gulf	Author	65	151.09	46	143.87
Coronation Gulf	Jenness	82	151.8	42	145.8
Victoria Island	Author	30	151.83	19	145.37
Mackenzie	Author	47	146.68	40	140.90
Mackenzie	Jenness	4	149.8	..	.....
Mackenzie (Koupagmiut)	Boas	12	144.0	6	141.5
Nunatagmiut	Author	64	154.48	55	148.46
Nunatagmiut	Boas	11	154.5	5	142.6
Barrow	Author	62	151.11	26	144.54
Point Hope	Jenness	13	150.6	..	.....
Kotzebue Sound	Author	30	151.60	8	142.50
Seward Peninsula	Shapiro	40	152.2	..	.....
St. Lawrence Island	Hrdlička	63	154.0	48	147.7
Southwest Alaska	Hrdlička	61	155.6	24	150.0
Asiatic Eskimo	Jochelson-Brodsky	60	153.0	80	146.8

in head length, while the Victoria Islanders are 0.74 mm. broader headed than the more southern Coronation Gulf men.

The females show the same general tendencies as do the males, the Mackenzie being by far the narrowest and the Nunatagmiut the broadest. The Victoria Island women follow the men in having a greater mean head breadth than the Coronation Gulf group.

In this table I have listed the mean cephalic indices of the male and female Eskimos. From the previous studies in head length and head breadth it is no surprise to find that the Mackenzie males show the lowest mean cephalic index 74.75, this figure being 2.51 index units lower than the next highest group, the Coronation Gulfers.

The Mackenzie are the only mean dolichocephalic group of all the Eskimos, for the rest have mesocephalic indices, including the Nunatagmiut who are practically brachycephalic with an index of 81.39.

The Kotzebue Sound and Barrow males have almost identical mean indices, while that of the Victoria Islanders, although quite similar to the afore-mentioned groups, is 1.04 index units higher than the Coronation Gulf mean.

A study of the female cephalic indices substantiates the facts observed among the males. Here too the lowest cephalic index is that of the Mackenzie women. The Nunatagmiut possess the highest mean index of 81.18, bordering on brachycephaly.

TABLE 5

Cephalic Index

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	73-87	78.60 ± 0.47	3.82 ± 0.33	4.86 ± 0.42
Barrow	62	73-87	78.55 ± 0.28	3.22 ± 0.20	4.10 ± 0.25
Nunatagmiut	64	76-89	81.39 ± 0.25	2.94 ± 0.18	3.61 ± 0.22
Mackenzie	48	68-82	74.75 ± 0.26	2.65 ± 0.18	3.55 ± 0.24
Victoria Island ...	30	75-82	78.30 ± 0.24	1.95 ± 0.17	2.49 ± 0.22
Coronation Gulf ..	65	69-82	77.26 ± 0.20	2.44 ± 0.14	3.16 ± 0.19
Females:					
Kotzebue Sound ..	8	72-79	77.00 ± 0.51	2.12 ± 0.36	2.75 ± 0.46
Barrow	26	73-83	78.12 ± 0.36	2.75 ± 0.26	3.52 ± 0.33
Nunatagmiut	55	76-88	81.18 ± 0.28	3.08 ± 0.20	3.79 ± 0.24
Mackenzie	40	70-82	75.38 ± 0.28	2.65 ± 0.20	3.52 ± 0.27
Victoria Island ...	19	74-84	77.79 ± 0.36	2.35 ± 0.26	3.02 ± 0.33
Coronation Gulf ..	46	73-80	76.24 ± 0.17	1.67 ± 0.12	2.19 ± 0.15

The Coronation Gulf mean is 1.55 units lower than that of the Victoria Island females. The 26 Barrow women have a cephalic index of 78.12 in contrast to the 77.00 mean index of the Kotzebue females. This difference may be due to the small number of individuals in the Kotzebue sample, although the standard deviation of 2.12 is fairly small.

It must not pass unnoticed that, with the exception of the Mackenzie, all the female groups have lower mean cephalic indices than the corresponding males.

Table 6 shows the grouping of all the Eskimos according to the divisions of the cephalic index. This statistical device has the advantage over the mean in that it distinguishes the various types of head form which are present in the group.

Among the males, the Kotzebue Sounders evidence a marked mesocephaly having 60.0 per cent of the individuals in this class, associated with fairly good size dolichocephalic and brachycephalic elements. The Barrow males have division percentages quite similar to those of their Kotzebue neighbors, except that they possess a larger brachycephalic class, which is doubtless due to Nunatagmiut admixture when the latter group came down to the coast in the whaling seasons.

TABLE 6

Divisions of the Cephalic Index

	DOLICHOCEPHALIC (x-76.9)		MESOCEPHALIC (77-81.9)		BRACHYCEPHALIC (82-x)		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Males:								
Kotzebue Sound ...	8	26.7	18	60.0	4	13.3	30	100
Barrow	16	25.8	33	53.2	13	21.0	62	100
Nunatagmiut	1	1.6	33	51.5	30	46.9	64	100
Mackenzie	38	79.2	9	18.7	1	2.1	48	100
Victoria Island	6	20.0	22	73.3	2	6.7	30	100
Coronation Gulf ...	18	27.7	46	70.8	1	1.5	65	100
Females:								
Kotzebue Sound ...	2	25.0	6	75.0	0	0	8	100
Barrow	6	23.1	16	61.5	4	15.4	26	100
Nunatagmiut	2	3.6	28	50.9	25	45.5	55	100
Mackenzie	26	65.0	13	32.5	1	2.5	40	100
Victoria Island	4	21.0	14	73.7	1	5.3	19	100
Coronation Gulf ...	24	52.2	22	47.8	0	0	46	100

TABLE 7

Comparative Table of Mean Cephalic Index

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
East Greenland	Hansen	..	76.9	..	75.2
Angmassalik (E. Greenland)	Hansen (1914)	31	77.8	15	76.5
Angmassalik (E. Greenland)	Poulsen	26	76.52	10	76.29
Southeast Greenland	Hansen (1914)	22	75.7	21	75.0
Southwest Greenland	Hansen (1914)	21	78.1	24	76.8
Greenland	Deniker (1913)	614	76.8	..	....
Smith Sound	Steensby	8	78.06	10	77.40
Labrador	Pittard	8	76.11	6	74.84
Labrador	Duckworth and Pain	11	77.0	5	74.5
Labrador	Virchow	3	75.5	2	72.0
Baffin Island	Oetteking	10	76.2	13	77.7
Southampton Island	Tocher	35	77.2	..	....
Hudson Bay	Birket-Smith	99	77.3	..	....
Coronation Gulf	Author	65	77.26	46	76.24
Coronation Gulf	Jenness	82	77.6	42	76.7
Victoria Island	Author	30	78.30	19	77.79
Mackenzie	Author	48	74.75	40	75.38
Mackenzie	Jenness	4	76.1	..	....
Mackenzie (Koupagmiut)	Boas	12	73.9	6	75.2
Nunatagmiut	Author	64	81.39	55	81.18
Nunatagmiut	Boas	11	81.6	5	78.8
Barrow	Author	62	78.55	26	78.12
Point Hope	Jenness	13	78.3	..	....
Kotzebue Sound	Author	30	78.60	8	77.0
Seward Peninsula	Shapiro	40	77.96	..	....
St. Lawrence Island	Hrdlička	63	79.7	48	79.6
Southwest Alaska	Hrdlička	61	80.7	24	79.6
Alaska	Boas (1895)	114	79.2	..	....
Asiatic Eskimo	Jochelson-Brodsky	60	80.8	80	79.7

The Nunatagmiut males are composed of two types, mesocephals and brachycephals, with about equal numbers in each classification. Of the 64 Nunatagmiut males there is only one individual who lays claim to dolichocephaly.

The Mackenzie males stand apart from all of the other groups in head form, 79.2 per cent of their number showing dolichocephaly, with only 18.7 per cent mesocephalic. This indeed emphasizes the distinctiveness of the Mackenzie Eskimo, for none of our other groups can compare with them in extreme length and narrowness of the cranial vault.

The Victoria Islanders and Coronation Gulf men show similarity in the percentage of individuals in the various classes, with the latter having a slightly greater tendency towards dolichocephaly.

The female Kotzebue and Barrow Eskimos approximate the male condition, with the exception of an absence of roundheads among the former.

The Nunatagmiut women show almost identical percentages with the males; and the Mackenzie, although they do not have as many dolichocephals as the men, exceed any of the other female groups in this characteristic.

The only marked divergence from the male results is found among the Coronation Gulf women, whose population is composed of almost equal numbers of dolichocephals and mesocephals.

TABLE 8

Face Height

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	112-140	127.73 ± 0.56	6.55 ± 0.57	5.13 ± 0.45
Barrow	62	116-149	129.63 ± 0.67	7.79 ± 0.47	6.01 ± 0.36
Nunatagmiut	64	102-142	127.06 ± 0.63	7.49 ± 0.45	5.89 ± 0.35
Mackenzie	47	109-140	125.57 ± 0.71	7.18 ± 0.50	5.72 ± 0.40
Victoria Island ...	30	112-140	125.20 ± 0.81	6.56 ± 0.57	5.22 ± 0.46
Coronation Gulf ..	65	111-146	127.72 ± 0.55	6.56 ± 0.39	5.14 ± 0.30
Females:					
Kotzebue Sound ..	8	107-128	119.25 ± 1.91	7.99 ± 1.01	6.70 ± 1.13
Barrow	25	98-130	119.40 ± 1.01	7.49 ± 0.71	6.27 ± 0.60
Nunatagmiut	53	101-129	120.38 ± 0.60	6.56 ± 0.43	5.45 ± 0.35
Mackenzie	40	96-133	117.08 ± 0.82	7.67 ± 0.58	6.55 ± 0.49
Victoria Island ...	19	112-135	121.68 ± 0.80	5.16 ± 0.56	4.24 ± 0.46
Coronation Gulf ..	45	110-140	121.73 ± 0.70	6.99 ± 0.50	5.74 ± 0.41

TABLE 9

Comparative Table of Mean Face Height

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Smith Sound	Steensby	8	125.28	10	118.30
Labrador	Duckworth and Pain	11	127.0	10	116.5
Labrador	Virchow	3	127.7	2	119.0
Hudson Bay	Birket-Smith	99	123.5	..	.....
Coronation Gulf	Author	65	127.72	45	121.73
Coronation Gulf	Jenness	82	126.9	42	121.7
Victoria Island	Author	30	125.20	19	121.68
Mackenzie	Author	47	125.57	40	117.08
Mackenzie (Koupagmiut)	Boas	12	131.5	6	120.8
Nunatagmiut	Author	64	127.06	53	120.38
Nunatagmiut	Boas	11	128.4	5	119.8
Barrow	Author	62	129.63	25	119.40
Kotzebue Sound	Author	30	127.73	8	119.25
Seward Peninsula	Shapiro	40	126.9	..	.....
St. Lawrence Island	Hrdlička	63	126.8	48	113.1
Southwest Alaska	Hrdlička	61	126.7	24	121.1
Asiatic Eskimo	Jochelson-Brodsky	60	131.07	..	125.04

This table gives the mean face heights of our six Eskimo groups. The shortest average a little above 125 mm. and are found among the Mackenzie and Victoria Island males. The Barrow men have the longest faces, showing an exceptionally high mean face height of 129.63 mm. The remaining groups, the Kotzebue, Nunatagmiut and Coronation Gulfers, all have means ranging around 127 mm.

The Eskimo women do not correspond to their respective male groups in mean face height, for although the Mackenzie females exhibit the shortest faces of all, the Victoria Islanders and Coronation Gulf women have the longest. Face height has been the only characteristic thus far studied wherein the females have not supported most of the differences found among the males.

On the basis of previous evidence we would expect to find the Nunatagmiut far exceeding all the other Eskimos in breadth of face. But strangely enough this is not so, for while the Nunatagmiut males have a mean face breadth of 147.05 mm. identical with the mean of the Coronation Gulfers, they are surpassed by the Kotzebue Sound men with a face breadth of 148.37 and the Victoria Islanders with 147.80. Unquestionably our Nunatagmiut group is composed of a narrower-headed leptoprosopic element as well as a brachycephalic broader-faced element as evidenced in part by the high standard deviation of 7.33 and the coefficient of variation of 4.98.

TABLE 10

Face Breadth

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	139-157	148.37 ± 0.61	4.93 ± 0.43	3.32 ± 0.29
Barrow	62	132-158	145.69 ± 0.55	6.45 ± 0.39	4.43 ± 0.27
Nunatagmiut	64	127-162	147.05 ± 0.62	7.33 ± 0.44	4.98 ± 0.30
Mackenzie	47	123-157	144.70 ± 0.60	6.09 ± 0.42	4.21 ± 0.29
Victoria Island ...	30	134-158	147.80 ± 0.66	5.34 ± 0.46	3.61 ± 0.31
Coronation Gulf ..	65	138-157	147.05 ± 0.39	4.64 ± 0.27	3.16 ± 0.19
Females:					
Kotzebue Sound ..	7	140-148	142.86 ± 0.72	2.83 ± 0.51	1.98 ± 0.36
Barrow	25	128-153	138.16 ± 0.71	5.30 ± 0.51	3.84 ± 0.37
Nunatagmiut	55	117-150	140.93 ± 0.50	5.46 ± 0.35	3.87 ± 0.25
Mackenzie	40	124-149	138.72 ± 0.56	5.26 ± 0.40	3.79 ± 0.29
Victoria Island ...	19	130-147	140.58 ± 0.68	4.42 ± 0.48	3.14 ± 0.34
Coronation Gulf ..	45	128-148	138.33 ± 0.36	3.54 ± 0.25	2.56 ± 0.18

TABLE 11

Comparative Table of Mean Face Breadth

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Angmassalik (E. Greenland)	Poulsen	25	144.84	10	136.80
Smith Sound	Steensby	8	147.75	10	141.50
Labrador	Pittard	8	144.62	6	136.00
Labrador	Duckworth and Pain	11	142.2	10	136.6
Labrador	Virchow	3	146.7	2	134.5
Hudson Bay	Birket-Smith	99	143.4	..	.....
Coronation Gulf	Author	65	147.05	45	138.33
Coronation Gulf	Jenness	82	145.7	42	137.8
Victoria Island	Author	30	147.80	19	140.58
Mackenzie	Author	47	144.70	40	138.72
Mackenzie	Jenness	3	145.0	..	.....
Mackenzie (Koupagmiut)	Boas	12	147.8	6	139.7
Nunatagmiut	Author	64	147.05	55	140.93
Nunatagmiut	Boas	11	155.7	5	144.6
Barrow	Author	62	145.69	25	138.16
Point Hope	Jenness	13	146.3	..	.....
Kotzebue Sound	Author	30	148.37	7	142.86
Seward Peninsula	Shapiro	40	149.3	..	.....
St. Lawrence Island	Hrdlička	63	147.3	48	140.3
Southwest Alaska	Hrdlička	61	149.5	24	143.1
Asiatic Eskimo	Jochelson-Brodsky	60	147.6	80	139.4

The Mackenzie Eskimos have the narrowest faces with a mean breadth of 144.70 mm., while the Barrow males are only 0.99 mm. broader.

The Nunatagmiut females are similar to the Victoria Islanders in mean face breadth as are the men, and again, are exceeded in this feature by the Kotzebue Sound women. Although the Mackenzie have comparatively narrow faces, they are nevertheless slightly broader than those of the Barrow and Coronation Gulf females.

Our Eskimos show a remarkable degree of variation in mean facial index, ranging from almost euryprosopism among the Victoria Islanders to distinct leptoprosopism among the Barrow males. The low index of 84.83 for the Victoria Islanders is due to their relatively short face heights, rather than to the breadth of their faces.

Although the Mackenzie men resemble the Kotzebue, Nunatagmiut and Coronation Gulfers in mean facial index, it must be remembered that they differ in having absolutely shorter and narrower faces.

Notwithstanding the fact that the Kotzebue Sound and Mackenzie females both have low indices bordering on euryprosopism, on examination we find that they are not due to similar factors, for, while the low index of the Mackenzie is the result of their short faces, the index of the Kotzebue Sound women may be traced to the excessive breadth of their faces rather than the height.

TABLE 12

Facial Index

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	75-95	86.10 ± 0.54	4.35 ± 0.38	5.05 ± 0.44
Barrow	62	79-99	89.00 ± 0.42	4.89 ± 0.30	5.49 ± 0.33
Nunatagmiut	63	73-96	86.51 ± 0.34	3.99 ± 0.24	4.61 ± 0.28
Mackenzie	46	79-96	86.80 ± 0.43	4.29 ± 0.30	4.94 ± 0.35
Victoria Island ...	30	77-92	84.83 ± 0.52	4.20 ± 0.37	4.95 ± 0.43
Coronation Gulf ..	65	77-103	86.94 ± 0.37	4.48 ± 0.27	5.15 ± 0.30
Females:					
Kotzebue Sound ..	7	78-91	84.86 ± 1.11	4.34 ± 0.78	5.12 ± 0.92
Barrow	25	76-95	86.52 ± 0.67	4.96 ± 0.47	5.73 ± 0.55
Nunatagmiut	53	69-95	85.34 ± 0.46	4.96 ± 0.32	5.81 ± 0.38
Mackenzie	39	67-93	84.23 ± 0.57	5.25 ± 0.40	6.23 ± 0.48
Victoria Island ...	19	81-92	86.43 ± 0.44	2.86 ± 0.31	3.31 ± 0.36
Coronation Gulf ..	45	79-98	88.27 ± 0.47	4.42 ± 0.31	5.01 ± 0.36

The highest mean facial index among the females is that of the Coronation Gulfers, 88.27, with the Victoria Island and Barrow women having indices about 2 units lower.

In Table 12 we noticed that the Victoria Island males possessed the lowest mean facial index of all the groups. In this table when all the individuals are classified on the basis of the facial index divisions, we find that this fact is substantiated, for the Victoria Islanders have, as do the Kotzebue Sound males, 33.3 per cent euryprosopic faces. This relationship between the two groups ends here, for the rest of the Victoria Islanders are mainly mesoprosopic while the remaining Kotzebue Sound males are distinctly leptoprosopic.

The Barrow men have a mean facial index of 89.00, the highest of all the groups, more than half of their number being leptoprosopic and only 17.7 per cent euryprosopic.

The Nunatagmiut males show a fair number of short-broad faced individuals, a moderate amount of mesoprosopists, and a still greater number of long and narrow faced types. The Mackenzie males and Coronation Gulfers are similar to the Nunatagmiut in divisions of the facial index as well as in mean facial index, except that the Mackenzie are not as long faced as the other two groups.

TABLE 13

Divisions of the Facial Index

	EURYPROSOPIC (x-83.9)		MESOPROSOPIC (84-87.9)		LEPTOPROSOPIC (88-x)		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Males:								
Kotzebue Sound ...	10	33.3	6	20.0	14	46.7	30	100
Barrow	11	17.7	15	24.2	36	58.1	62	100
Nunatagmiut	14	22.2	21	33.3	28	44.5	63	100
Mackenzie	10	21.8	18	39.1	18	39.1	46	100
Victoria Island	10	33.3	13	43.3	7	23.4	30	100
Coronation Gulf ...	12	18.5	22	33.8	31	47.7	65	100
Females:								
Kotzebue Sound ...	3	42.8	2	28.6	2	28.6	7	100
Barrow	7	28.0	6	24.0	12	48.0	25	100
Nunatagmiut	17	32.1	16	30.2	20	37.7	53	100
Mackenzie	17	43.6	8	20.5	14	35.9	39	100
Victoria Island	4	21.1	7	36.8	8	42.1	19	100
Coronation Gulf ...	6	13.3	15	33.3	24	53.4	45	100

TABLE 14

Comparative Table of Mean Facial Index

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Smith Sound	Steensby	8	85.29	10	83.64
Labrador	Duckworth and Pain	11	89.2	10	87.0
Labrador	Virchow	3	87.1	2	88.5
Hudson Bay	Birket-Smith	99	86.1	..	....
Coronation Gulf	Author	65	86.94	45	88.27
Coronation Gulf	Jenness	82	87.0	42	88.3
Victoria Island	Author	30	84.83	19	86.43
Mackenzie	Author	46	86.80	39	84.23
Mackenzie (Koupagmiut)	Boas	12	88.9	6	86.6
Nunatagmiut	Author	63	86.51	53	85.34
Nunatagmiut	Boas	11	82.8	5	83.1
Barrow	Author	62	89.00	25	86.52
Kotzebue Sound	Author	30	86.10	7	84.86
Seward Peninsula	Shapiro	40	84.92	..	....
St. Lawrence Island	Hrdlička	63	86.7	48	80.6
Southwest Alaska	Hrdlička	61	84.9	24	84.6
Asiatic Eskimo	Jochelson-Brodsky	60	88.8	78	89.7

It is interesting to note that in the main, all the male groups are predominantly leptoprosopic, with the exception of the Victoria Islanders who possess a greater percentage of mesoprosopic than leptoprosopic faces.

At the first cursory glance at the females, it is evident that they are not as long and narrow faced as the males, for the Mackenzie and Kotzebue females are more euryprosopic than leptoprosopic. The Coronation Gulf, Victoria Island, and Barrow women are the most leptoprosopic groups among the females.

Cephalo-facial index, the relation between breadth of face and breadth of head, becomes a very important index when we are dealing with Eskimo or Indian material. In respect to the latter it has been found that the pure-blooded American Indians usually have mean cephalo-facial indices ranging from about 94 to 98. It has also been demonstrated by Jenks [10] and Sullivan,[11] that when Indians absorb some white blood the first evidence of their mixture is portrayed by the cephalo-facial index which drops below 94 and sometimes as low as 89. In *Indian and white mixtures,* the index falls, due to the *decrease in diameters,* the decrease in face breadth exceeding the decrease in head breadth.

TABLE 15

Cephalo-Facial Index

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Kotzebue Sound ..	30	91-103	97.90 ± 0.40	3.23 ± 0.28	3.30 ± 0.29
Barrow	62	89-103	96.48 ± 0.28	3.25 ± 0.20	3.37 ± 0.20
Nunatagmiut	63	79-103	95.27 ± 0.40	4.73 ± 0.28	4.96 ± 0.30
Mackenzie	46	92-108	98.98 ± 0.36	3.60 ± 0.25	3.64 ± 0.26
Victoria Island ...	30	91-102	97.47 ± 0.31	2.50 ± 0.22	2.56 ± 0.22
Coronation Gulf ..	65	89-105	97.29 ± 0.23	2.76 ± 0.16	2.84 ± 0.17
Females:					
Kotzebue Sound ..	7	97-105	100.14 ± 0.66	2.59 ± 0.47	2.59 ± 0.47
Barrow	25	90-100	95.56 ± 0.32	2.38 ± 0.23	2.49 ± 0.24
Nunatagmiut	54	86-101	95.09 ± 0.28	3.12 ± 0.20	3.28 ± 0.21
Mackenzie	39	89-108	98.41 ± 0.38	3.50 ± 0.27	3.56 ± 0.27
Victoria Island ...	19	90-101	96.68 ± 0.47	3.04 ± 0.33	3.14 ± 0.34
Coronation Gulf ..	46	92-101	96.20 ± 0.22	2.20 ± 0.15	2.29 ± 0.16

[10] Jenks, 1916.

[11] Sullivan, 1920.

The pure-blooded male Eskimos have mean cephalo-facial indices that are higher than those of the Indians, varying from approximately 96 to 100. It appears that when Indian blood enters the Eskimo groups, the mean cephalo-facial index falls, but rarely below 95. Thus, in *Eskimo and Indian mixtures,* the index falls, due to the ***increase in diameters,*** the increase in cranial breadth exceeding the increase in facial breadth. When we discover Eskimo groups with mean cephalo-facial indices below 95, we can be quite sure we are dealing with an appreciable amount of white mixture, especially if we can demonstrate that it is due to a decrease in diameters, for, in ***Eskimo and white mixtures,*** the index falls as a result of a ***decrease in diameters,*** the decrease in facial breadth exceeding the decrease in cranial width.

With these facts in mind, we find on examination of Table 15 that none of our male groups show any evidence of white blood, but that the Nunatagmiut unquestionably betray their Athapaskan admixture in the comparatively low cephalo-facial index of 95.27. The most eskimoid group, the Mackenzie, possess the highest mean index, 98.98, while the remaining groups have face breadths that are a little more than 97 per cent of the breadth of their heads, with the exception of the Barrow who show an index of 96.48.

The 7 Kotzebue Sound females have a very high mean cephalo-facial index of 100.14, but this is probably due to the small size of the series and must therefore not be considered seriously. The Mackenzie women exceed the rest of the female groups with a mean index of 98.41, and again the Nunatagmiut have the lowest index, 95.09, followed closely by the Barrow whose mean index is only 0.47 index units higher.

If we accept the proposition that the great size of face breadth relative to head breadth is an index of the purity of Eskimo blood, then we must admit that the Mackenzie Eskimos are the purest Eskimos of all. It would also follow that the Nunatagmiut have had a great deal of Indian admixture in comparatively recent times. The intermediate position of the Kotzebue Sounders, Victoria Islanders and Coronation Gulfers gives the possibility of some degree of Indian admixture, but this supposition may best be left for further elaboration later.

In this table I have sorted all the individuals on the basis of a two-fold classification, each one being classified both as to his cephalic index and facial index. Thus, all the dolichocephalic types may be either dolicho-euryprosopic, dolicho-mesoprosopic, or dolicho-leptoprosopic.

TABLE 16

Comparative Table of Mean Cephalo-Facial Index

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Angmassalik (E. Greenland)	Poulsen	25	98.44	10	97.78
Smith Sound	Steensby	8	96.56	10	97.65
Labrador	Pittard	8	97.66	6	95.49
Labrador	Duckworth and Pain	11	96.4	10	96.3
Labrador	Virchow	3	98.4	2	98.4
Hudson Bay	Birket-Smith	99	95.8	..	....
Coronation Gulf	Author	65	97.29	46	96.20
Coronation Gulf	Jenness	82	96.0	42	94.6
Victoria Island	Author	30	97.47	19	96.68
Mackenzie	Author	46	98.98	39	98.41
Mackenzie (Koupagmiut)	Boas	12	102.7	6	99.0
Nunatagmiut	Author	63	95.27	54	95.09
Nunatagmiut	Boas	11	100.8	5	101.6
Barrow	Author	62	96.48	25	95.56
Kotzebue Sound	Author	30	97.90	7	100.14
Seward Peninsula	Shapiro	40	98.15	..	.....
St. Lawrence Island	Hrdlička	63	95.6	48	95.0
Southwest Alaska	Hrdlička	61	96.1	24	95.4
Asiatic Eskimo	Jochelson-Brodsky	60	96.6	80	96.3

TABLE 17

TABLE 17

Association of Cranial Types with Facial Types

	KOTZEBUE		BARROW		NUNATAGMIUT		MACKENZIE		VIC. ISLAND		COR. GULF	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
					Males							
Dolicho-Euryprosopic	0	0	1	1.6	0	0	9	19.6	1	3.3	2	3.1
Dolicho-Mesoprosopic	2	6.7	3	4.8	0	0	15	32.6	3	10.0	7	10.8
Dolicho-Leptoprosopic	6	20.0	12	19.4	1	1.6	13	28.2	2	6.7	9	13.8
Meso-Euryprosopic	8	26.7	7	11.3	7	11.1	1	2.2	9	30.0	9	13.8
Meso-Mesoprosopic	3	10.0	7	11.3	10	15.8	4	8.7	9	30.0	15	23.1
Meso-Leptoprosopic	7	23.3	19	30.6	16	25.4	3	6.5	4	13.4	22	33.9
Brachy-Euryprosopic	2	6.7	3	4.8	7	11.1	0	0	0	0	1	1.5
Brachy-Mesoprosopic	1	3.3	5	8.1	11	17.5	0	0	1	3.3	0	0
Brachy-Leptoprosopic	1	3.3	5	8.1	11	17.5	1	2.2	1	3.3	0	0
Totals	30	100	62	100	63	100	46	100	30	100	65	100
					Females							
Dolicho-Euryprosopic	1	14.3	1	4.0	0	0	10	25.6	2	10.5	2	4.4
Dolicho-Mesoprosopic	1	14.3	0	0	0	0	6	15.4	1	5.3	7	15.6
Dolicho-Leptoprosopic	0	0	5	20.0	2	3.7	9	23.1	1	5.3	15	33.3
Meso-Euryprosopic	2	28.6	4	16.0	5	9.3	6	15.4	2	10.5	4	8.9
Meso-Mesoprosopic	1	14.3	5	20.0	8	14.8	2	5.1	6	31.6	8	17.8
Meso-Leptoprosopic	2	28.6	6	24.0	14	25.9	5	12.8	6	31.6	9	20.0
Brachy-Euryprosopic	0	0	2	8.0	12	22.2	1	2.6	0	0	0	0
Brachy-Mesoprosopic	0	0	1	4.0	8	14.8	0	0	0	0	0	0
Brachy-Leptoprosopic	0	0	1	4.0	5	9.3	0	0	1	5.3	0	0
Totals	7	100	25	100	54	100	39	100	19	100	45	100

The mesocephals and brachycephals are also divided in this fashion, so that every individual must fall into one of our 9 groups.

In examining the males, we find that the Kotzebue Sound group consists mainly of dolicho-leptoprosopic, meso-euryprosopic and meso-leptoprosopic types. The Barrow dolichos are leptoprosopic and the mesocephals are also long and narrow faced. The surprising fact about the Nunatagmiut group is that along with the meso and brachy types, we find a very small percentage of euryprosopism, for the mesocephals are mostly leptoprosopic while the brachycephals are markedly mesoprosopic and leptoprosopic.

The Victoria Islanders are excessively mesocephalic and have faces that are euryprosopic and mesoprosopic, while the Coronation Gulfers differ from them in having 33.9 per cent meso-leptoprosopic individuals.

The small size of the Kotzebue female series prevents us from arriving at any definite conclusions as to the associations of facial with cranial types; but among the Barrow women, the dolichocephals are notably leptoprosopic with the mesocephals having all types of faces. The Nunatagmiut females are predominately meso-leptoprosopic and brachy-euryprosopic. The Mackenzie dolichocephals and mesocephals show very few mesoprosopic faces but seem to run more to the extreme types.

The Victoria Islanders differ again from their southern Coronation Gulf neighbors, the former being in the main meso-mesoprosopic and meso-leptoprosopic, while the latter are excessively dolicho-leptoprosopic with a fair amount of meso-leptoprosopism.

It was indeed unfortunate that Stefansson was unable to obtain stature and sitting height measurements on more individuals and on

TABLE 18

Stature in cm.

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Barrow	24	149-184	164.59 ± 1.14	8.26 ± 0.80	5.02 ± 0.49
Nunatagmiut	26	155-180	169.12 ± 0.90	6.78 ± 0.63	4.01 ± 0.38
Mackenzie	25	159-179	168.96 ± 0.74	5.45 ± 0.52	3.23 ± 0.31
Females:					
Barrow	7	150-161	153.71 ± 0.98	3.84 ± 0.69	2.49 ± 0.45
Nunatagmiut	13	147-164	155.08 ± 0.96	5.14 ± 0.68	3.31 ± 0.44
Mackenzie	16	144-163	155.50 ± 1.00	5.93 ± 0.71	3.81 ± 0.45

TABLE 19

Comparative Table of Mean Stature

MALES FEMALES

AUTHORITY

GROUP

TABLE 19

Comparative Table of Mean Stature

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Angmassalik (E. Greenland)	Hansen (1914)	31	164.7	15	155.1
Angmassalik (E. Greenland)	Poulsen	26	162.35	10	149.13
Southeast Greenland	Hansen (1914)	22	160.4	23	152.9
Southwest Greenland	Hansen (1914)	21	157.6	24	151.8
West Greenland	Hansen (1893)	..	162.0	..	152.0
Greenland	Deniker	614	162.1	..	.....
Smith Sound	Steensby	8	157.4	10	145.4
Labrador	Pittard	8	158.2	6	155.6
Labrador	Duckworth and Pain	11	157.7	10	149.7
Labrador	Virchow	3	159.7	2	148.6
Labrador	Boas (1895)	26	157.5	..	148.0
Cumberland Sound (Baffin Land)	Boas (1907)	9	162.0	12	151.8
Cumberland Strait (Baffin Land)	Sutherland (1856)	23	158.50	30	148.08
Baffin Island	Oetteking	10	162.4	13	147.9
Hudson Bay	Birket-Smith	99	160.6	..	.....
Melville Peninsula	Parry (1824)	20	166.0	20	153.7
Southampton Island	Tocher	35	162.0	..	.....
Coronation Gulf	Jenness	82	164.8	42	156.4
Mackenzie	Author	25	168.96	16	155.50
Mackenzie (Koupagmiut)	Boas	12	167.5	6	151.5
Nunatagmiut	Author	26	169.12	13	155.08
Nunatagmiut	Boas	11	167.9	5	155.6
Barrow	Author	24	164.59	7	153.71
Point Hope	Jenness	13	166.5	..	.....
Seward Peninsula	Shapiro	39	165.4	..	.....
St. Lawrence Island	Hrdlička	63	163.3	48	151.35
Southwest Alaska	Hrdlička	61	162.4	24	153.10
Alaska	Boas (1895)	34	165.8	..	155.1
Alaska	Deniker (1913)	85	163.0	..	.....
Asiatic Eskimo	Jochelson-Brodsky	61	162.3	80	151.8

more Eskimo groups; yet, we must accept with ready hands all the evidence we can possibly obtain in order to help piece together the fragmentary evidence bearing upon Eskimo history.

The Nunatagmiut and Mackenzie males present the tallest mean statures that have heretofore been assigned to any Eskimo group. A mean stature approximating 169 cm. places these Eskimos in what Martin [12] calls the "Mittelgrosse Gruppen." The Barrow men with a mean stature of 164.59 are far shorter than their more eastern relatives.

The females support the males in this characteristic with the Mackenzie and Nunatagmiut women being taller than the Barrow group.

In this instance, due to the absence of measurements on the lower extremities, sitting height becomes a very important measurement, for it indicates whether the magnitude of the stature lies in the torso or the lower limbs.

Curiously enough the tallest group, the male Nunatagmiut, have the shortest mean sitting height, which is smaller than that of the lower statured Barrow Eskimos. The Mackenzie males with a stature not quite as great as the Nunatagmiut have the largest mean sitting height of 91.20 cm. Evidently the tall stature of the Nunatagmiut group lies in the lower limbs, while that of the Mackenzie is inherent in the torso or vertebral column and head.

TABLE 20

Sitting Height

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Barrow	22	78-96	88.18 ± 0.57	3.93 ± 0.40	4.46 ± 0.45
Nunatagmiut	21	76-98	86.43 ± 0.63	4.30 ± 0.45	4.98 ± 0.52
Mackenzie	10	84-96	91.20 ± 0.76	3.57 ± 0.54	3.91 ± 0.59
Females:					
Barrow	5	79-86	82.20 ± 0.69	2.27 ± 0.51	2.76 ± 0.59
Nunatagmiut	12	79-88	82.67 ± 0.48	2.46 ± 0.34	2.98 ± 0.41
Mackenzie	11	79-90	85.54 ± 0.74	3.65 ± 0.52	4.27 ± 0.61

[12] Martin, 1928.

TABLE 21

Comparative Table of Mean Sitting Height

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Angmassalik (E. Greenland)	Poulsen	24	86.79	10	79.98
Smith Sound	Steensby	8	82.5	10	78.1
Labrador	Duckworth and Pain	11	81.0	10	79.7
Southampton Island	Tocher	35	85.2	..	....
Mackenzie	Author	10	91.20	11	85.54
Mackenzie (Koupagmiut)	Boas	12	89.3	6	81.2
Nunatagmiut	Author	21	86.43	12	82.67
Nunatagmiut	Boas	11	86.8	5	81.8
Barrow	Author	22	88.18	5	82.20
St. Lawrence Island	Hrdlička	63	88.40	48	84.07
Southwest Alaska	Hrdlička	61	89.00	24	84.36

Relative sitting height is an index which gives the ratio of sitting height to stature. The higher the index the greater is the length of the torso in relation to the total stature of the individual.

Therefore, the Nunatagmiut males and females have longer legs or shorter bodies relative to their statures than either the Mackenzie or Barrow groups. The Barrow males and Mackenzie females have relatively the longest bodies or the shortest legs.

STATISTICAL COMPARISONS

Up to this point, I have presented the summary of the measurements of the six Eskimo groups without attempting to demonstrate the relationships existent between them. Now it is my purpose, by means of statistical devices, to detect the differences and similarities between the groups and to show their statistical significance beyond a reasonable doubt.

Accordingly, I have calculated the differences between the means of the various groups and the probable errors of these differences. And finally their relationship was expressed in terms of "xpe," obtained by dividing the differences between means by the probable errors of the differences.

In the following tables, I have used this statistical method to compare one Eskimo group with another. There are differences between every group, but now it is possible to demonstrate which differences are significant beyond a reasonable doubt, and which ones are merely different due to random sampling.

The first column of every table contains the means and probable errors of the main group subject to comparison. The rest of the groups

TABLE 22

Relative Sitting Height

	NO.	RANGE	MEAN	S. D.	C. V.
Males:					
Barrow	22	52-56	53.68 ± 0.18	1.26 ± 0.13	2.35 ± 0.24
Nunatagmiut	21	47-55	51.52 ± 0.28	1.92 ± 0.20	3.73 ± 0.39
Mackenzie	10	50-57	53.30 ± 0.33	1.55 ± 0.23	2.91 ± 0.44
Females:					
Barrow	5	52-56	53.60 ± 0.49	1.63 ± 0.35	3.04 ± 0.65
Nunatagmiut	11	50-56	53.45 ± 0.36	1.78 ± 0.26	3.33 ± 0.48
Mackenzie	11	53-57	55.18 ± 0.26	1.27 ± 0.18	2.30 ± 0.33

TABLE 23

Comparative Table of Mean Relative Sitting Height

GROUP	AUTHORITY	MALES		FEMALES	
		No.	Mean	No.	Mean
Angmassalik (E. Greenland)	Poulsen	24	53.31	10	53.64
Smith Sound	Steensby	8	52.4	10	53.7
Labrador	Duckworth and Pain	11	51.4	10	53.3
Southampton Island	Tocher	35	52.6	..	....
Mackenzie	Author	10	53.30	11	55.18
Mackenzie (Koupagmiut)	Boas	12	53.5	6	53.7
Nunatagmiut	Author	21	51.52	11	53.45
Nunatagmiut	Boas	11	52.6	5	52.4
Barrow	Author	22	53.68	5	53.60
St. Lawrence Island	Hrdlička	63	54.13	48	55.55
Southwest Alaska	Hrdlička	61	54.90	24	55.10

have two columns, the first giving the differences between means for each measurement, and at the base of which I have computed the average of the differences irrespective of signs; the second column headed by "xpe" gives the number of times the difference exceeds the probable error of the difference.

All differences that have xpe's over 3.00 are unquestionably significant differences and are printed in bold faced type, for the chances are more than 96 out of 100 that such differences are not due to random sampling. Those differences that are between 2 and 3 times their own probable errors, whose chances of being significant are from 82 to 96 out of 100, may be said to be possibly or probably significant and are printed in italics. All differences having an xpe less than 2.00 are considered to be differences due merely to the random sampling process.

In Table 24 I have compared the measurements and indices of the Kotzebue men and women with those of the rest of the Eskimos.

The most striking feature of this table is the extraordinarily close resemblance between the Kotzebue Sound and Victoria Island males. There is no question about this similarity, for the Victoria Islanders are significantly different only in one characteristic, face height, and this is but a possibly significant difference. This fact is all the more remarkable when we consider that the Kotzebue Sound people live on the northwest coast of Alaska, while the Victoria Islanders are far to the eastward, north of Coronation Gulf. The average difference between the Kotzebue and the Victoria Island males is only 0.99.

The Victoria Island females do not evidence as great a similarity with the Kotzebue females, but this may be possibly due to the extremely small size of the Kotzebue sample, there being but 8 in the series.

The next closest relationship is found between the Kotzebue and Coronation Gulf males, the latter being significantly different in head length and possibly different in cephalic index.

Although the Barrow are most closely situated to the Kotzebue, the males show more differences than with the Victoria Islanders and Coronation Gulfers, the Barrow being significantly different in face breadth and facial index, and possibly different in face height and cephalo-facial index.

The Nunatagmiut and Mackenzie males show no evidence of similarity with the Kotzebue Sound Eskimos.

The Kotzebue females are in general distinguished from the rest of the women in having narrower heads, much broader faces and extremely high cephalo-facial indices.

From Table 25 the Barrow males appear to be most closely related to their Kotzebue neighbors. The rest of the groups show no apparent similarity to the Barrow men.

The Barrow females do not differ from their Eskimo relatives as do the males, for the Victoria Island women are inseparable physically from the Barrow with only one possibly significant difference, face breadth, and having an average difference of 1.26. Although the Coronation Gulf females show more significant differences than the Victoria Islanders, they are still closer to the Barrow than are the Kotzebue Sound women.

Table 26 contrasts the Nunatagmiut with the other Eskimo groups. The most outstanding feature of this table is the fact that the Nunatagmiut do not exhibit any close relationships with the other Eskimos. They have the shortest heads, the broadest heads, the highest cephalic indices, the lowest cephalo-facial indices, and the lowest relative sitting height of all the Eskimos considered in this paper.

These are all Indian-like features and clearly betray the presence of considerable Indian blood that must have entered this group in comparatively recent times.

An examination of Table 27 accentuates all the distinctive characteristics of the Mackenzie Eskimo. There is no group, either among the males or females, that can claim any close relationship with them whatsoever. They are distinguished from the rest of the Eskimos by the absence of Indian tendencies and by the exaggeration of Eskimo features. The Mackenzie heads are the longest, narrowest, with the lowest cephalic indices; their faces are the narrowest with very high cephalo-facial indices; and the relation of sitting height to stature indicates that they are endowed with very long trunks.

If we take all these facts into consideration, and if we accept the relation between the breadth of head and the breadth of face as being an index of purity of Eskimo blood, then we must conclude that the Mackenzie are the most Eskimoid of all the Eskimos.

There are three important facts, concerning the Victoria Island males, that are indicated in Table 28.

The first one pertains to the outstanding similarity between the Victoria Island and Kotzebue males which has been already pointed out.

TABLE 24

Differences Between Means of Kotzebue Sound and Other Eskimo Males and Females

	KOTZEBUE	BARROW		NUNATAGMIUT		MACKENZIE		VICTORIA IS.		CORO. GULF	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	192.50 ± 0.72	—0.11	—0.12	**—2.47**	—3.01	**3.76**	4.13	1.63	1.75	**3.21**	3.73
Head Breadth	151.60 ± 0.77	—0.49	—0.53	**2.88**	3.39	**—4.92**	—5.60	0.23	0.25	—0.51	—0.60
Cephalic Index	78.60 ± 0.47	—0.05	—0.09	**2.79**	5.27	**—3.85**	—7.13	—0.30	—0.57	*—1.34*	—2.63
Face Height	127.73 ± 0.56	*1.90*	2.19	—0.67	—0.80	*—2.16*	—2.40	*—2.53*	—2.60	—0.01	—0.01
Face Breadth	148.37 ± 0.61	**—2.68**	—3.27	—1.32	—1.52	**—3.67**	—4.32	—0.57	—0.63	—1.32	—1.83
Facial Index	86.10 ± 0.54	**2.90**	4.20	0.41	0.62	0.70	1.01	—1.27	—1.70	0.84	1.28
Cephalo-Facial Index.	97.90 ± 0.40	*—1.42*	—2.90	**—2.63**	—4.61	*1.08*	2.00	—0.43	—0.84	—0.61	—1.33
Average differences.....		1.36		1.88		2.88		0.99		1.12	
Females											
Head Length	185.00 ± 0.45	—0.12	—0.16	**—2.09**	—3.37	*1.90*	2.53	1.74	1.51	**3.70**	5.70
Head Breadth	142.50 ± 0.92	2.04	1.94	**5.96**	5.96	—1.60	—1.60	*2.87*	2.50	1.37	1.37
Cephalic Index	77.00 ± 0.51	1.12	1.81	**4.18**	7.21	*—1.62*	—2.80	0.79	1.27	—0.76	—1.41
Face Height	119.25 ± 1.91	0.15	0.07	1.13	0.56	—2.17	—1.04	2.43	1.17	2.48	1.22
Face Breadth	142.86 ± 0.72	**—4.70**	—4.65	*—1.93*	—2.19	**—4.14**	—4.55	*—2.28*	—2.30	**—4.53**	—5.60
Facial Index	84.86 ± 1.11	1.66	1.28	0.48	0.40	—0.63	—0.50	1.57	1.32	*3.41*	2.84
Cephalo-Facial Index.	100.14 ± 0.66	**—4.58**	—6.19	**—5.05**	—7.01	*—1.73*	—2.28	**—3.46**	—4.27	**—3.94**	—5.63
Average differences.....		2.05		2.97		1.97		2.15		2.88	

TABLE 25

TABLE 25

Differences Between Means of Barrow and Other Eskimo Males and Females

	BARROW	KOTZEBUE		NUNATAGMIUT		MACKENZIE		VICTORIA IS.		CORO. GULF	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	192.39 ± 0.54	0.11	0.12	**—2.36**	—3.52	**3.87**	4.96	*1.74*	2.20	**3.32**	4.67
Head Breadth	151.11 ± 0.49	0.49	0.53	**3.37**	5.62	**—4.43**	—6.92	0.72	1.04	—0.02	—0.03
Cephalic Index	78.55 ± 0.28	0.05	0.09	**2.84**	7.49	**—3.80**	—9.74	—0.25	—0.70	**—1.29**	—3.70
Face Height	129.63 ± 0.67	*—1.90*	—2.19	*—2.57*	—2.79	**—4.06**	—4.14	**—4.43**	—4.22	*—1.91*	—2.20
Face Breadth	145.69 ± 0.55	**2.68**	3.27	1.36	1.66	—0.99	—1.30	*2.11*	2.33	*1.36*	2.03
Facial Index	89.00 ± 0.42	**—2.90**	—4.20	**—2.49**	—4.53	**—2.20**	—3.67	**—4.17**	—6.22	**—2.06**	—3.44
Cephalo-Facial Index.	96.48 ± 0.28	*1.42*	2.90	*—1.21*	—2.48	**2.50**	5.44	*0.99*	2.36	*0.81*	2.26
Stature	164.59 ± 1.14	....	....	**4.53**	3.12	**4.37**	3.95	....	....	....	....
Sitting Height	88.18 ± 0.57	....	....	*—1.75*	—2.06	**3.02**	3.18	....	....	....	....
Relative Sitting Height	53.68 ± 0.18	....	....	**—2.16**	—6.55	—0.38	—1.03	....	....	....	....
Average differences.....		1.36		2.46		2.96		2.06		1.54	
Females											
Head Length	184.88 ± 0.61	0.12	0.16	*—1.97*	—2.67	*2.02*	2.38	1.76	1.44	**3.82**	4.96
Head Breadth	144.54 ± 0.51	**—2.04**	—1.94	**3.92**	6.13	**—3.64**	—5.78	0.83	0.97	—0.67	—1.03
Cephalic Index	78.12 ± 0.36	—1.12	—1.81	**3.06**	6.66	**—2.74**	—5.96	—0.33	—0.65	**—1.88**	—4.70
Face Height	119.40 ± 1.01	—0.15	—0.07	0.98	0.83	—2.32	—1.78	2.28	1.78	2.33	1.89
Face Breadth	138.16 ± 0.71	**4.70**	4.65	**2.77**	3.19	0.56	0.62	*2.42*	2.47	0.17	0.22
Facial Index	86.52 ± 0.67	—1.66	—1.28	—1.18	—1.46	*—2.29*	—2.60	—0.09	—0.11	*1.75*	2.13
Cephalo-Facial Index.	95.56 ± 0.32	**4.58**	6.19	—0.47	—1.12	**2.85**	5.81	1.12	1.97	0.64	1.65
Stature	153.71 ± 0.98	....	....	1.37	1.00	1.79	1.28	....	....	....	....
Sitting Height	82.20 ± 0.69	....	....	0.47	0.56	**3.84**	3.31	....	....	....	....
Relative Sitting Height	53.60 ± 0.49	....	....	—0.15	—0.24	*1.58*	2.82	....	....	....	....
Average differences.....		2.05		1.63		2.31		1.26		1.61	

TABLE 26

Differences Between Means of Nunatagmiut and Other Eskimo Males and Females

	NUNATAGMIUT	KOTZEBUE		BARROW		MACKENZIE		VICTORIA IS.		CORO. GULF	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	190.03 ± 0.40	**2.47**	3.01	**2.36**	3.52	**6.23**	9.02	**4.10**	5.78	**5.68**	9.16
Head Breadth	154.48 ± 0.39	**—2.88**	—3.39	**—3.37**	—5.62	**—7.80**	—14.44	**—2.65**	—4.50	**—3.39**	—6.78
Cephalic Index	81.39 ± 0.25	**—2.79**	—5.27	**—2.84**	—7.49	**—6.64**	—18.33	**—3.09**	—8.83	**—4.13**	—12.91
Face Height	127.06 ± 0.63	0.67	0.80	*2.57*	2.79	—1.49	—1.57	—1.86	—1.81	0.66	0.79
Face Breadth	147.05 ± 0.62	1.32	1.52	—1.36	—1.66	*—2.35*	—2.73	0.75	0.82	0.00	0.00
Facial Index	86.51 ± 0.34	—0.41	—0.62	**2.49**	4.53	0.29	0.53	*—1.68*	—2.71	0.43	0.84
Cephalo-Facial Index.	95.27 ± 0.40	**2.63**	4.61	*1.21*	2.48	**3.71**	6.87	**2.20**	4.31	**2.02**	4.40
Stature	169.12 ± 0.90	....	....	**—4.53**	—3.12	—0.16	—0.14	....	....	....	....
Sitting Height	86.43 ± 0.63	....	....	*1.75*	2.06	**4.77**	4.82	....	....	....	....
Relative Sitting Height	51.52 ± 0.28	....	....	**2.16**	6.55	**1.78**	4.05	....	....	....	....
Average differences.....		1.88		2.46		3.52		2.33		2.33	
Females											
Head Length	182.91 ± 0.43	**2.09**	3.37	*1.97*	2.67	**3.99**	5.39	**3.83**	3.36	**5.79**	9.19
Head Breadth	148.46 ± 0.39	**—5.96**	—5.96	**—3.92**	—6.13	**—7.56**	—14.00	**—3.09**	—3.91	**—4.59**	—8.20
Cephalic Index	81.18 ± 0.28	**—4.18**	—7.21	**—3.06**	—6.66	**—5.80**	—14.50	**—3.39**	—7.37	**—4.94**	—14.97
Face Height	120.38 ± 0.60	—1.13	—0.56	—0.98	—0.83	**—3.30**	—3.27	1.30	1.30	1.35	1.47
Face Breadth	140.93 ± 0.50	*1.93*	2.19	**—2.77**	—3.19	*—2.21*	—2.95	—0.35	—0.42	**—2.60**	—4.23
Facial Index	85.34 ± 0.46	—0.48	—0.40	1.18	1.46	—1.11	—1.52	*1.39*	2.21	**2.93**	4.44
Cephalo-Facial Index.	95.09 ± 0.28	**5.05**	7.01	0.47	1.12	**3.32**	7.07	*1.59*	2.89	**1.11**	3.84
Stature	155.08 ± 0.96	....	....	—1.37	—1.00	0.42	0.30	....	....	....	....
Sitting Height	82.67 ± 0.48	....	....	—0.47	—0.56	**2.87**	3.26	....	....	....	....
Relative Sitting Height	53.45 ± 0.36	....	....	0.15	0.24	**1.73**	3.84	....	....	....	....
Average differences.....		2.97		1.63		3.23		2.13		3.33	

TABLE 27

Differences Between Means of Mackenzie and Other Eskimo Males and Females

	MACKENZIE	KOTZEBUE		BARROW		NUNATAGMIUT		VICTORIA IS.		CORO. GULF	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	196.26 ± 0.56	**—3.76**	—4.13	**—3.87**	—4.96	**—6.23**	—9.02	*—2.13*	—2.63	—0.55	—0.76
Head Breadth	146.68 ± 0.41	**4.92**	5.60	**4.43**	6.92	**7.80**	14.44	**5.15**	8.18	**4.41**	8.02
Cephalic Index	74.75 ± 0.26	**3.85**	7.13	**3.80**	9.74	**6.64**	18.33	**3.55**	9.87	**2.51**	7.61
Face Height	125.57 ± 0.71	*2.16*	2.40	**4.06**	4.14	1.49	1.57	—0.37	—0.36	*2.15*	2.42
Face Breadth	144.70 ± 0.60	**3.67**	4.32	0.99	1.30	*2.35*	2.73	**3.10**	3.49	**2.35**	3.31
Facial Index	86.80 ± 0.43	—0.70	—1.01	**2.20**	3.67	—0.29	—0.53	*—1.97*	—2.94	0.14	0.25
Cephalo-Facial Index.	98.98 ± 0.36	*—1.08*	—2.00	**—2.50**	—5.44	**—3.71**	—6.78	**—1.51**	—3.15	**—1.69**	—4.02
Stature	168.96 ± 0.74	....	....	**—4.37**	—3.95	0.16	0.14	....	....	....	....
Sitting Height	91.20 ± 0.76	....	....	**—3.02**	—3.18	**—4.77**	—4.82	....	....	....	....
Relative Sitting Height	53.50 ± 0.33	....	....	0.38	1.03	**—1.78**	—4.05	....	....	....	....
Average differences.....		2.88		2.96		3.52		2.54		1.98	
Females											
Head Length	186.90 ± 0.60	*—1.90*	—2.53	*—2.02*	—2.38	**—3.99**	—5.39	—0.16	—0.13	*1.80*	2.37
Head Breadth	140.90 ± 0.37	1.60	1.60	**3.64**	5.78	**7.56**	14.00	**4.47**	5.66	**2.97**	5.40
Cephalic Index	75.38 ± 0.28	*1.62*	2.80	**2.74**	5.96	**5.80**	14.50	**2.41**	5.24	*0.86*	2.61
Face Height	117.08 ± 0.82	2.17	1.04	2.32	1.78	**3.30**	3.27	**4.60**	4.00	**4.65**	4.31
Face Breadth	138.72 ± 0.56	**4.14**	4.55	—0.56	—0.62	*2.21*	2.95	*1.86*	2.11	—0.39	—0.59
Facial Index	84.23 ± 0.57	0.63	0.50	*2.29*	2.60	1.11	1.52	**2.20**	3.10	**4.04**	5.46
Cephalo-Facial Index.	98.41 ± 0.38	*1.73*	2.28	**—2.85**	—5.81	**—3.32**	—7.07	*—1.73*	—2.88	**—2.21**	—5.02
Stature	155.50 ± 1.00	....	....	—1.79	—1.28	—0.42	—0.30	....	....	....	....
Sitting Height	85.54 ± 0.74	....	....	**—3.34**	—3.31	**—2.87**	—3.26	....	....	....	....
Relative Sitting Height	55.18 ± 0.26	....	....	*—1.58*	—2.82	**—1.73**	—3.84	....	....	....	....
Average differences.....		1.97		2.31		3.23		2.49		2.42	

TABLE 28

Differences Between Means of Victoria Island and Other Eskimo Males and Females

	VICTORIA IS.	KOTZEBUE		BARROW		NUNATAGMIUT		MACKENZIE		CORO. GULF	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	194.13 ± 0.58	—1.63	—1.75	*—1.74*	—2.20	**—4.10**	—5.78	*2.13*	2.63	*1.58*	2.10
Head Breadth	151.83 ± 0.48	—0.23	—0.25	—0.72	—1.04	**2.65**	4.50	**—5.15**	—8.18	—0.74	—1.23
Cephalic Index	78.30 ± 0.24	0.30	0.57	0.25	0.70	**3.09**	8.83	**—3.55**	—9.87	**—1.04**	—3.25
Face Height	125.20 ± 0.81	*2.53*	2.60	**4.48**	4.22	1.86	1.81	0.37	0.36	*2.52*	2.57
Face Breadth	147.80 ± 0.66	0.57	0.63	*—2.11*	—2.33	—0.75	—0.82	**—3.10**	—3.49	—0.75	—0.98
Facial Index	84.83 ± 0.52	1.27	1.70	**4.17**	6.22	*1.68*	2.71	*1.97*	2.94	**2.11**	3.29
Cephalo-Facial Index.	97.47 ± 0.31	0.43	0.84	*—0.99*	—2.36	**—2.20**	—4.31	**1.51**	3.15	—0.18	—0.47
Average differences.....		0.99		2.06		2.33		2.54		1.27	
Females											
Head Length	186.74 ± 1.06	—1.74	—1.51	—1.76	—1.44	**—3.83**	—3.36	0.16	0.13	1.96	1.69
Head Breadth	145.37 ± 0.69	*—2.87*	—2.50	—0.83	—0.97	**3.09**	3.91	**—4.47**	—5.66	—1.50	—1.88
Cephalic Index	77.79 ± 0.36	—0.79	—1.27	0.33	0.65	**3.89**	7.37	**—2.41**	—5.24	**—1.55**	—3.87
Face Height	121.68 ± 0.80	—2.43	—1.17	—2.28	—1.78	—1.30	—1.30	**—4.60**	—4.00	0.05	0.05
Face Breadth	140.58 ± 0.68	*2.28*	2.30	*—2.42*	—2.47	0.35	0.42	*—1.86*	—2.11	*—2.25*	—2.92
Facial Index	86.43 ± 0.44	—1.57	—1.32	0.09	0.11	*—1.39*	—2.21	**—2.20**	—3.10	*1.84*	2.83
Cephalo-Facial Index.	96.68 ± 0.47	**3.46**	4.27	—1.12	—1.97	*—1.59*	—2.89	*1.73*	2.88	—0.48	—0.92
Average differences.....		2.15		1.26		2.13		2.49		1.38	

TABLE 29

Differences Between Means of Coronation Gulf and Other Eskimo Males and Females

	COR. GULF	KOTZEBUE		BARROW		NUNATAGMIUT		MACKENZIE		VICTORIA IS.	
Males	Mean	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.	diff.	xpe.
Head Length	195.71 ± 0.47	**—3.21**	—3.73	**—3.32**	—4.67	**—5.68**	—9.16	0.55	0.76	*—1.58*	—2.10
Head Breadth	151.09 ± 0.36	0.51	0.60	0.02	0.03	**3.39**	6.78	**—4.41**	—9.02	0.74	1.23
Cephalic Index	77.26 ± 0.20	*1.34*	2.63	**1.29**	3.70	**4.13**	12.91	**—2.51**	—7.61	**1.04**	3.25
Face Height	127.72 ± 0.55	0.01	0.01	*1.91*	2.20	—0.66	—0.79	*—2.15*	—2.42	*—2.52*	—2.57
Face Breadth	147.05 ± 0.39	1.32	1.83	*—1.36*	—2.03	0.00	0.00	**—2.35**	—3.31	0.75	0.98
Facial Index	86.94 ± 0.37	—0.84	—1.28	**2.06**	3.44	—0.43	—0.84	—0.14	—0.25	**—2.11**	—3.29
Cephalo-Facial Index.	97.29 ± 0.23	0.61	1.33	*—0.81*	—2.26	**—2.02**	—4.40	**1.69**	4.02	0.18	0.47
Average differences.....		1.12		1.54		2.33		1.98		1.27	
Females											
Head Length	188.70 ± 0.47	**—3.70**	—5.70	**—3.82**	—4.96	**—5.79**	—9.19	*—1.80*	—2.37	—1.96	—1.69
Head Breadth	143.87 ± 0.40	—1.37	—1.37	0.67	1.03	**4.59**	8.20	**—2.97**	—5.40	1.50	1.88
Cephalic Index	76.24 ± 0.17	0.76	1.41	**1.88**	4.70	**4.94**	14.97	*—0.86*	—2.61	**1.55**	3.87
Face Height	121.73 ± 0.70	—2.48	—1.22	—2.33	—1.89	—1.35	—1.47	**—4.65**	—4.31	0.05	0.05
Face Breadth	138.33 ± 0.36	**4.53**	5.60	—0.17	—0.22	**2.60**	4.23	0.39	0.59	*2.25*	2.92
Facial Index	88.27 ± 0.47	*—3.41*	—2.84	*—1.75*	—2.13	**—2.93**	—4.44	**—4.04**	—5.46	*—1.84*	—2.83
Cephalo-Facial Index.	96.20 ± 0.22	**3.94**	5.63	—0.64	—1.65	**—1.11**	—3.84	**2.21**	5.02	0.48	0.92
Average differences.....		2.88		1.61		3.33		2.42		1.38	

The second demonstrates that the Kotzebue Sound Eskimos are more like the Victoria Island men than the geographically more closely situated Coronation Gulf group. And finally, the Victoria Islanders lean toward Canadian Indian features to a greater degree than their southern Coronation Gulf neighbors.

The female Victoria Island series shows unusual identity with the Barrow, more so than with the Coronation Gulfers. The Kotzebue women would not differ very much from the Victoria Islanders were it not for the former's extremely high cephalo-facial index. Again as in the males, the Victoria Island females show greater Indian tendencies in physical features than the Coronation Gulf group.

The male Coronation Gulf Eskimos resemble the Kotzebue Sound men more than they do the Victoria Islanders.

The Victoria Island females are fairly similar to the Coronation Gulf women, being significantly different in cephalic index by 1.55 points, and possibly different in face breadth and facial index.

DISCUSSION

The science of anthropology, although usually subdivided into its various branches, ethnology, ethnography, somatology and archaeology, is essentially a closely knit and interrelated study. The examination of no single branch alone is adequate if a thorough understanding of a cultural group is to be obtained. It is necessary, in a study of the historical background and culture of a people, that cognizance be taken of all the factors that went into the making of that cultural pattern. It is the complete devotion to all the evidence at our command,—the somatological, the ethnological, the archaeological and the ethnographical—which will reveal to us the true history, the true cultural pattern of a people.

Nowhere is this statement more pertinent than in the question of the origin of the Eskimos. It is essential that we bring to bear all the evidence we have in order to solve this perplexing problem.

Thus far those who have unearthed the archaeological data, those who have determined the ethnological material, those who have studied the geographical distribution of the Eskimo, have failed adequately to bring into relation their results with the available somatological data. In this paper I intend to correlate the physical evidence concerning the Eskimo with the known facts of material culture that have been eluci-

dated by such eminent authorities as Boas, Steensby, Rasmussen, Mathiassen, Birket-Smith and Jenness.

Many theories have been postulated for the origin of the Eskimo and the sequence of Eskimo cultures, but the most complete and comprehensive theory has been presented by Birket-Smith.[13] The various cultures in chronological sequence he gives as follows:

(1) *Proto-Eskimo*—a "circumpolar ice-hunting culture" in the remote past, the Caribou Eskimos west of Hudson Bay being the last survivors.

(2) *Palae-Eskimo*—the bearers of this culture were once Proto-Eskimo but were the first group to adapt themselves to life at the sea, spreading all over the Arctic.

(3) *Thule*—corresponds to Steensby's Neo-Eskimo culture,[14] originating in the west, most probably in Alaska, then spreading eastward to Greenland. The Thulers depended mainly on the hunting of whales.

(4) *Eschato-Eskimo*—represented by the Central Eskimo cultures. The bearers of this culture have fairly recently migrated north from inland.

In addition to the above we must add the as yet little known "Bering Sea Culture" discovered in Alaska, which is considered by Jenness[15] to be older than the Thule.

Archaeologists and ethnologists are in complete agreement as to the existence of the Thule and the more recent Eschato-Eskimo cultures. But they disagree as to the Proto- and Palae-Eskimo cultures as expounded by Birket-Smith. For example, Mathiassen[16] cannot find evidence for the presence of an older culture in the central regions than the Thule.

The question of the Proto- and Palae-Eskimos need not concern us at this point, but let us instead examine the somatological evidence for the Thule and Eschato-Eskimo cultures.

The Bearers of the Old Thule Culture

Mathiassen[17] has pointed out the fact that on the basis of various cultural evidences it was apparent that the Thule culture originated in

[13] Birket-Smith, 1928 and 1929.
[14] Steensby, 1910.
[15] Jenness, 1928.
[16] Mathiassen, 1930.
[17] Mathiassen, 1927.

western Alaska and from that focus spread eastwards right to Greenland. What were the physical characteristics of the bearers of this culture was not known, until fortunately, in 1918, Van Valin [18] discovered a group of mounds near Point Barrow, Alaska, which contained a series of skeletal remains associated with artifacts of Thule type. That this culture belonged to the Thule people is a fact that has been adequately and conclusively demonstrated by Mason.[19] And further, that this was a historically ancient site is attested to by Van Valin, who on questioning the present inhabitants of Point Barrow, found that they had no historical recollection of the existence of any previous group in this region, or that these mounds were actually "Igloos."

These important skeletons were measured in 1928 by Hrdlička [20] who came to the conclusion that the bones of the Old Igloo Thulers were the remains of Eskimos whose physical type differed radically from groups now living in Alaska. On the basis of his report, the skeletal remains are distinguished by the great length and extreme narrowness of their skulls, with consequently low cranial indices, and also by their excessively high breadth-height indices. In short, the Old Igloo Thulers were described as a tall statured, dolichocephalic, orthocephalic, akrocephalic, hypsiconch, leptorrhine group.

These skeletons represent an individually characteristic and distinctive type which is clearly differentiated from almost all other Eskimo craniometric series. They are distinguished from them in possessing the longest skulls, by far the narrowest skulls, the lowest cranial indices, the highest skull vaults, the highest cephalo-facial and breadth-height indices, and one of the tallest statures.

Do any of the existing Eskimo groups resemble this skeletal series by exhibiting similar characteristic features, or has this type entirely disappeared into the existing populations? A survey of the physical characteristics of the existing Eskimo tribes brings to light the fact that of all the groups, the Mackenzie seem to fit this description best. We have seen, in previous pages, how the measurements and indices of this group stamped them apart from all the rest. These Mackenzie were described as the most Eskimoid of all the Eskimos. There was no group in the material studied that could lay claim to any close relationship with them whatsoever. The Mackenzie Eskimos were distinguished

[18] Hrdlička, 1930.
[19] Mason, 1928.
[20] Hrdlička, 1930.

from the other living groups in having the longest heads, the narrowest heads, the lowest cephalic indices, one of the highest cephalo-facial indices, and one of the tallest statures. Thus it may be seen that the Mackenzie Eskimos differ from the other living groups in the same characteristics and in the same direction as do the Old Igloo crania from the other Eskimo skeletal collections.

The fact that these two groups differ markedly from all the other groups in similar measurements and indices, in the same direction, and are both extreme types, leads one to suspect that they are of the same racial stock. Both are very long headed, both are very narrow headed, both have very low cranial indices, very high cephalo-facial indices, and tall statures.

Such close resemblances between two groups cannot be fortuitous, but on the other hand are a cogent argument for the postulation of racial identity, thereby confirming the conclusion that *physically the Mackenzie Eskimos are the living descendants of the original bearers of the old Thule culture.*

Are there any other Eskimos who resemble the Old Igloo Thulers in physical characteristics? From the geographical distribution of archaeological remains of the Thule type one would expect the Smith Sound, Baffin Land, Labrador and Greenland Eskimos to show close somatological likenesses with the Old Igloo people. Nevertheless, we do not find this condition, for the physical type has been changed, probably as the result of the penetration of newer peoples into these regions and the extinction of the Thulers.

Mason [21] has made the following statement:

> it may now be stated that the bearers of the Thule Culture in Alaska were of a definite physical type and, according to Doctor Hrdlička, this type is identical with that of the present Eskimo of Southern Greenland and Labrador, and different from that of the modern Alaskan Eskimo.

I can find no evidence to substantiate this quotation in its entirety; in fact, all the material that we have, meager though it is, refutes some of these suppositions. *The present Labrador Eskimos do not resemble the Old Igloo Thulers.* The former have shorter and wider heads, higher cephalic indices, longer faces, and much lower cephalo-facial indices. Most important of all is the fact that their statures are in no manner alike, the Labrador Eskimo being very short, having a mean

[21] Mason, 1928.

stature of about 157 cm., while the Old Igloo Thulers stand about 12.5 cm. taller, with a mean of 169.50 cm.

A study of the anthropometric data on the Greenland Eskimos does reveal some resemblances in physical features with the Thulers. Hrdlička, in 1929, emphasized a close connection between the Old Igloo skeletons and a series of undated crania from Greenland. In facial dimensions there appeared many "striking similarities." However, in regard to the proportions of the cranial vault these similarities were not so impressive. The mean difference between the two series for cranial length was 2.8 mm., cranial breadth 3.1 mm., cranial height 0.7 mm., cranial index 2.7, and for the height-breadth index 3.0 index units. These differences although not widely divergent are not small enough to presume physical identity, especially inasmuch as we are dealing with two series of the same racial grouping. Nevertheless, taking all the Greenland evidence as a whole, it may be stated that *the Eskimos of that country have a basic strain of Thule blood* which has been overlayed to a variable degree by a new infusion of a very short-statured, low-headed group, concerning which more will be said later.

Bessel's [22] measurements of a series of 100 Smith Sound crania would throw considerable light upon the question of Thule inhabitants in that far north region, if the skulls had been sexed. Unfortunately, the unsexed data cannot be interpreted with any amount of confidence, so that we shall have to wait until this valuable collection is re-examined.

In summary of the existing knowledge concerning the bearers of the Thule Culture, we may say that the Mackenzie Eskimos are their only approximately pure living descendants, although traces of their blood can be found in other parts of the Arctic, particularly as a basic substratum in Greenland.

The Eschato-Eskimos

The present Central Eskimos, extending from Coronation Gulf to Baffin Land and Labrador, are the representatives of the modern Eschato-Eskimo culture. It is a commonly accepted proposition that this culture is later than that of the Thule, and that it appeared in its existing position only after the decline of the Thule Eskimos.

In support of this thesis, Mathiassen, Birket-Smith, Boas, Jenness and others have shown that in comparatively recent times there has been

[22] Bessel, 1875.

a new advance of inland tribes from the region west of Hudson Bay to the Central Eskimo lands. This migration is supposed to have imposed upon the scattered remnants of the Old Thulers the new Eschato culture. Birket-Smith [23] has proven that the Caribou Eskimo have in historic times arrived at the Barren Grounds from inland regions, when the Chipewyan Indians retreated to the south. Jenness [24] came to the conclusion that the Copper Eskimos were originally an inland people who have reached their present position within the last few hundred years.

Practically all of these hypotheses are based upon archeological and cultural data. The task for the physical anthropologist is to determine on the basis of somatological evidence, whether associated with this new advance of Eschato Culture, there has been a regular migration of new peoples or just an infiltration of cultural elements.

To Dr. H. L. Shapiro [25] must be given the credit for establishing for the first time a physical relationship between an interior Indian tribe and certain Eskimo groups. He sees close resemblances in physical features between the Chipewyan Indians on the one hand, and the Smith Sound, Coronation Gulf, and Seward Peninsula Eskimos on the other. In conclusion, Shapiro postulates that these Eskimos "are derived from an Indian stock which migrated northward to the coast and then moved northeastward to Smith Sound and westward to Seward Peninsula."

In Table 30, I have contrasted the pure Chipewyan Indian series measured by Grant with several Eskimo groups. An examination of the measurements and indices supports Shapiro's contention of a close physical relationship between the Chipewyan Indians and Seward Peninsula Eskimos, and, in my opinion, a more minute study would extend this relationship to include several other western Alaskan coast Eskimos, the Kotzebue Sound, St. Lawrence Island and Southwest Alaskans.

We can hardly question the striking likeness the Chipewyan Indians show with the Copper Eskimos. Yet, I feel that some distinction should be made between the Copper Eskimos of Coronation Gulf and those of Victoria Island. From the limited measurements we have, there is no doubt that the Victoria Island group is physically almost inseparable from the pure Chipewyan, the average differences between the means being only 0.94. On the other hand, the Coronation Gulf Eskimos

[23] Birket-Smith, 1929.
[24] Jenness, 1923 b.
[25] Shapiro, 1931.

TABLE 30

Comparison Between Chipewyan Males and Western and Central Eskimos

No.	CHIPEWYAN PURE (44)	SOUTHWEST ALASKA (61)	ST. LAWRENCE ISLAND (63)	SEWARD PENINSULA (40)	KOTZEBUE SOUND (30)	VICTORIA ISLAND (30)	CORONATION GULF (65)	CORONATION GULF (82)	SMITH SOUND (8)
Measurements	Grant	Hrdlička	Hrdlička	Shapiro	Author	Author	Author	Jenness	Steensby
Head Length	193.5	192.9	193.3	195.3	192.50	194.13	195.71	195.9	196.25
Head Breadth	153.7	155.6	154.0	152.2	151.60	151.83	151.09	151.8	152.75
Cephalic Index	79.3	80.7	79.7	77.96	78.60	78.30	77.26	77.6	78.06
Face Height	125.3	126.7	126.8	126.9	127.73	125.20	127.72	126.9	125.28
Face Breadth	149.6	149.5	147.3	149.3	148.37	147.80	147.05	145.7	147.75
Facial Index	83.8	84.9	86.7	84.92	86.10	84.83	86.94	87.0	85.29
Cephalo-Facial Index	97.6	96.1	95.6	98.15	97.90	97.47	97.29	96.0	96.56
Stature	166.4	162.4	163.3	165.4	.....	.....	.....	164.8	157.4
Differences									
Head Length	193.5	—0.6	—0.2	1.8	—1.00	0.63	2.21	2.4	2.75
Head Breadth	153.7	1.9	0.3	—1.5	—2.10	—1.87	—1.61	—1.9	—0.95
Cephalic Index	79.3	1.4	0.4	—1.34	—0.70	—1.00	—2.04	—1.7	—1.24
Face Height	125.3	1.4	1.5	1.6	2.43	—0.10	2.42	1.6	—0.02
Face Breadth	149.6	—0.1	—2.3	—0.3	—1.23	—1.80	—2.55	—3.9	—1.85
Facial Index	83.8	1.1	2.9	1.12	2.30	1.03	2.14	3.2	1.49
Cephalo-Facial Index	97.6	—1.5	—2.0	0.55	0.30	—0.13	—0.31	—1.6	—1.04
Stature	166.4	—4.0	—3.1	—1.0	.....	.....	.....	—1.6	9.00
Average differences		1.50	1.59	1.15	1.44	0.94	1.90	2.24	2.29

measured by Stefansson [26] and Jenness vary considerably from the Chipewyan, with average differences for the Stefansson series of 1.90 and 2.24 for those of Jenness.[27]

The Coronation Gulf and Victoria Island Eskimos are fundamentally one and the same group of people with more or less identical culture, therefore, it is most probable that this physical difference between them can be accounted for on the basis of the greater assimilation by the Coronation Gulfers of a different racial strain. I maintain that this foreign blood was that of the Old Thulers.

It seems clear that when the Coronation Gulf Eskimos arrived at their present geographical position, they found some scattered remnants of the bearers of the Old Thule culture and it was with these Eskimos that they mixed. Although the Thulers were in all likelihood not very numerous, enough were absorbed to cause a change in the physical type of the invading group. The Victoria Island Eskimos retained more of their original physical characteristics, as shown by their shorter and wider heads and higher cephalic indices, because on entering their district they did not encounter as many of the older Thule inhabitants as did their more southern relatives. This theory is substantiated by the fact that archeologists have found more abundant Thule remains in the Coronation Gulf region than along the shores of Prince Albert Sound and Minto Inlet in Victoria Island.

In respect to the Smith Sound-Chipewyan relationship, the situation is not very clear. We are faced with an obstacle of generalizing from a series of 8 individuals. The average difference between their means has been calculated to be 2.29. This is not a small average difference, but still not excessively large. The difficulty arises in reconciling the exceedingly small stature of the Smith Sound Eskimos (157.4 cm.) with the much taller Chipewyans who have a mean of 166.4 cm. This great stature difference of 9 cm., in my opinion, is sufficient grounds for calling in question the Chipewyan origin of the Smith Sound Eskimo.

On the other hand, it may be possible that the physical status of the Smith Sound group revolves about the historical migration of some

[26] This paper.

[27] In comparing my Coronation Gulf Eskimos with those of Jenness it should be noted that under this heading Jenness has included 7 individuals from Prince Albert Sound and 34 from the southwest corner of Victoria Island, so that exactly half of Jenness' Coronation Gulf Eskimos would be according to my classification Victoria Islanders.

Pond's Inlet Eskimos into Smith Sound. The result of this new element was that the people measured by Steensby were a mixture of the indigenous population and the immigrants from the southwest.

Steensby [28] in describing these people writes: "Those I met were on the whole small, but there are not a few in the tribe who are above the average height. It is said that those who are descended from the Pond's Inlet Eskimos belong to the tallest in the tribe."

This goes to prove that although the invaders were few in number, they undoubtedly altered to some extent the physical constitution of the residing group. Who the indigenous population of Smith Sound were, is a question which I shall discuss soon. Let it suffice for the present to state that unquestionably they were of very small stature.

To summarize the influence of the Athapaskans of Chipewyan stock we may conclude that:

(1) The present inhabitants of the western coast of Alaska as far north as Point Hope, are the descendants of an invasion of people resembling the Athapaskans of Chipewyan stock. In this group we have the Eskimos from Kotzebue Sound, Seward Peninsula, St. Lawrence Island and Southwest Alaska.

(2) The Copper Eskimos are also related to the Athapaskan Chipewyans. The Coronation Gulfers are a mixture of the new invaders and the Old Thulers who still survived in that locality, while the Victoria Islanders retained their purity because of their being more or less out of the range of the Thule culture peoples.

(3) The Smith Sound Eskimos may be said to be very indirectly related to the Athapaskan Chipewyans, and that only if we infer that the Pond's Inlet immigrants were of Chipewyan-Eschato origin.

Cree Influence

Another great division of the Eschato-Eskimo cultural advance is that participated in by the Central Eskimos in the region of Hudson Bay, including the intensively studied Caribou Eskimo, Netsilik and Iglulik groups.

In reference to the historical occupation by the Caribou Eskimo of their present territory, Birket-Smith [29] relates how the comparatively recent expansion of the Chipewyan Indians into the southern part of

[28] Steensby, 1910.
[29] Birket-Smith, 1929.

the Barren Grounds exterminated "an old offshoot of the Old Thule Culture." The stimulus to this advance of the Athapaskans he charges to the introduction of firearms. The same authority also maintains that when the Chipewyans retired to the timber line, on the cessation of the pressure of the Crees from the south, the Caribou Eskimo took possession of the Barren Lands now left empty by the Chipewyans.

In addition, on purely cultural evidence, Birket-Smith [29] has propounded the theory that the present Caribou Eskimos are the last survivors of the Proto-Eskimo, a part of whom ventured to the coast in the region of Coronation Gulf and Bathurst Inlet, developed the Palae-Eskimo culture, and then spread eastward and westward along the coast.

There are two possibilities: (1) either we must accept Birket-Smith's point of view that the Caribou Eskimos are a very ancient group of survivors of the Proto-Eskimos, (2) or the Caribou Eskimos are not survivors of the Proto-Eskimo but are a new inland group which has come down to the coast as part of the late Eschato advance.

But before we consider this question let us determine the physical status of the Caribou Eskimo and demonstrate his affiliations.

In any event, whether or not Birket-Smith is right, one would expect to find on the basis of their inland origin, that the Hudson Bay Eskimos resemble an Indian stock physically. Fortunately, in the preliminary reports of the Fifth Thule Expedition,[30] there has been published a summary of a few of the measurements taken on Hudson Bay Eskimos. In Table 31 I have contrasted this series with a group of Algonkian Cree Indians measured by Grant at Fort Chipewyan.

The results are truly startling, for we do not find any large variations between any of the measurements or indices. Disregarding signs, the average difference is but 0.59. Both the Cree and the Hudson Bay Eskimos are characterized by mesocephaly tending towards dolichocephaly, fairly short and narrow faces and short stature. We cannot escape the conclusion that the Cree Indians and the Hudson Bay Eskimos are physically identical.

In addition, from the cultural point of view, the relation of the Caribou Eskimos to an Indian stock has been fully discussed by Birket-Smith, who derives most of the Indian cultural influences from the Algonkian Cree Indians. He says: [31]

[30] Birket-Smith, 1925.
[31] Birket-Smith, 1929.

In now concluding the reference to the Indian elements in the culture of the Caribou Eskimos, there is reason for emphasizing once more, that *in those cases where it was possible to trace them back to a particular tribe, it was to the Cree and not to the Chipewyan.*[32] This quite conforms to the historical facts, as the connection with the latter is scarcely 200 years old, whereas the intercourse with the Cree, now practically at an end, is much older.

Thus on the basis of both physical and cultural grounds, the Caribou Eskimos are unquestionably related to the Cree Indians.

The Caribou or Hudson Bay Eskimos do not possess, as regards physical make-up, particular features which distinguish them from all of the other Eskimos and mark them out as being a separate and distinct type. On the contrary, they are but a single group of a certain type of Eskimo that is characterized by short stature, dolichocephaly bordering on mesocephaly, and fairly short and narrow faces. It is interesting to note at this point that they differ from those Eskimos related to the Athapaskan Chipewyans in having a much shorter stature, narrower head, slightly shorter heads, much narrower faces as well as shorter faces.

A survey of the existing Eskimo tribes shows that this type to which the Caribou Eskimos belong is also exemplified by the Labrador and Angmassalik Eskimos of East Greenland. In Table 32 I have tabulated the measurements and indices for these groups, and, although the Angmassalik series is not complete, lacking face height and facial index, it can be seen that they exhibit such close similarities to the others as to make the Hudson Bay, Labrador and Angmassalik Eskimos divisions of the same racial type.

Furthermore, an examination of the crania and long bones of the eastern Eskimo leads me to believe that before the inception of foreign white influence, that part of the Arctic from Hudson Bay to the east coast of Greenland was populated by this short-statured, almost mesocephalic, narrow-faced group.

We must not lose sight of the fact that this type was not the original Eskimo in these parts, but came later than the Thulers. In many localities these invaders encountered scattered bands of the Old Thulers, some of whom were exterminated and others absorbed. This succession of the Thulers by the short-statured type is substantiated by numerous Tunit or Tornit legends,[33] which relate how the ancestors of the present

[32] His italics, not mine.

[33] Hawkes, 1916.

TABLE 31

Comparison Between Means of Cree Indians at Fort Chipewyan and Hudson Bay Males

	CREE (Grant)	HUDSON BAY (Birket-Smith)	Diff.	
Head Length	193.2	193.7	0.5	
Head Breadth	150.0	149.7	—0.3	
Cephalic Index	77.6	77.3	—0.3	
Face Height	124.6	123.5	—1.1	Average difference 0.59
Face Breadth	144.6	143.4	—1.2	
Facial Index	86.1	86.0	—0.1	
Cephalo-Facial Index	96.6	95.8	—0.8	
Stature	161.0	160.6	—0.4	

TABLE 32

Comparison Between Means of Cree and Hudson Bay, Labrador and Angmassalik Eskimo Males

	CREE	HUDSON BAY	LABRADOR	ANGMASSALIK
Measurements				
Head Length	193.2	193.7	192.9	192.27
Head Breadth	150.0	149.7	148.1	147.08
Cephalic Index	77.6	77.3	76.5	76.52
Face Height	124.6	123.5	127.1	.....
Face Breadth	144.6	143.4	143.7	144.84
Facial Index	86.1	86.0	88.7	.....
Cephalo-Facial Index	96.6	95.8	96.7	98.44
Stature	161.0	160.6	157.8	162.35
Differences				
Head Length	193.2	0.5	—0.3	—0.93
Head Breadth	150.0	—0.3	—1.9	—2.92
Cephalic Index	77.6	—0.3	—1.1	—1.08
Face Height	124.6	—1.1	2.5	.....
Face Breadth	144.6	—1.2	—0.9	0.24
Facial Index	86.1	—0.1	2.6	.....
Cephalo-Facial Index	96.6	—0.8	0.1	1.84
Stature	161.0	—0.4	—3.2	1.35
Average differences		0.59	1.57	1.39

central and eastern Eskimos met and lived with a very tall statured Eskimo (Thulers), who were finally assimilated or destroyed.

I have shown, on the basis of somatological criteria, that the Hudson Bay Eskimos are undeniably related to a particular group of Cree Indians. I have also pointed out how the Hudson Bay, Labrador and Angmassalik Eskimos all belong to a single physical type. It follows, therefore, that this short-statured type of which the Hudson Bay tribes are members, is also closely affiliated with the Cree.

To emphasize this relationship, in Table 32, I have computed the average differences between the measurements and indices of the groups in question and the Algonkian Cree Indians studied at Fort Chipewyan. These differences are really so small as to warrant the presumption of close affinities with the Cree, and the conclusion that the short-statured dolichocephalic (almost mesocephalic) type, which spread over the whole eastern Arctic, was originally derived from an Indian stock resembling the Algonkian Cree.

If we now consider the question of the aboriginal population of Smith Sound we find more evidence available. From Steensby's data and from a study of the raw measurements of Bessel's unsexed crania, it seems most likely, that before the arrival of the Pond's Inlet immigrants the Smith Sounders were also of this short-statured dolicho type described above. The effect of the Pond's Inlet Eskimos was to increase the cranial and facial diameters of the original Smith Sound group. However, we cannot be absolutely certain of these facts until Bessel's series is sexed and re-examined.

In Greenland today, both the east and west coasts are racially so mixed that very few pure Eskimos are to be found. There is no doubt in my mind that the bearers of the Thule Culture arrived here, but not in any great numbers. The Eskimos who have maintained their purity up to the present, are usually of the short-statured dolicho group. Occasionally, we find among them a few tall individuals, who are probably descendants of the Old Thulers. We must also remember that Danish, Norwegian, German and other mixtures have been going on for many years. This white blood is altering the physical characteristics of the Greenland Eskimos who are beginning to evince taller statures, broader heads, much narrower and longer faces, with consequently low cephalofacial indices.

If we return to the question of the Proto-Eskimo origin of the Caribou Eskimos as expounded by Birket-Smith, we find that on the

basis of physical evidence the Caribou Eskimos are related to the Algonkians of Cree stock. It has also been demonstrated that the Labrador and Angmassalik tribes are also affiliated with the same Indian group. It follows, therefore, that if we assume the Caribou Eskimo to be of Proto-Eskimo origin, then the Labrador and Angmassalik groups must have originated from the same stock. But since it is a well established fact that archaeologically the Thule Culture is the oldest in the eastern and central regions, the other cultures being superimposed upon it, then it would seem more probable that the Caribou Eskimo are not survivors of the Proto-Eskimo but rather a division of the late advance of the Eschato culture.

CONCLUSIONS

Throughout this discussion I have been fully aware of the fact that in certain places, the available material was of a scanty and meagre nature. Nevertheless, important evidence has appeared, which throws light upon the question of the immediate origin of the Eskimo and has produced definite indications as to the association of physical types with cultural radiations. Most anthropologists agree with Dr. Hrdlička on the problem of the ultimate origin of the Eskimo placing the genesis of this group somewhere in the Asiatic continent where it became differentiated as a limb of the great Mongoloid division of mankind. However, it is the question of the local or immediate home of the Eskimo which has raised tremendous controversy and which has produced two schools of thought. The first group would place the immediate origin of the Eskimo in the region of Alaska, from which point they are supposed to have spread eastwards along the Arctic coasts into Greenland. The second school contends that the immediate origin of the Eskimo should be placed somewhere in the Central Hudson Bay region, originally inland, but finally following the rivers to the coast and then migrating westward to Alaska and eastward to Labrador and Greenland.

According to the results of this monograph, both of these previously irreconcilable views may now be brought *en rapport* to form a new and complete picture as follows:

Two distinct cultures, the Thule originating from the Alaskan region, and the Eschato from the Central region, one superimposed upon the other, and identified with distinct physical types may be clearly discerned from the mass of data.

It appears that the earlier Thule Culture was carried by a very tall, extremely dolichocephalic, hypsicephalic Eskimo group whose home was somewhere in the west. These people, with whaling as their main cultural background, spread over the whole Arctic from Alaska to Greenland. The Mackenzie Eskimo, east of the Mackenzie River delta, represent their only approximately pure living descendants.

At a much later period, allied with the Eschato Culture advance, there was a sudden Indianoid expansion from central Canada from about the region of Lake Athabaska. From this focus these migrations into the Eskimo regions, replacing and superimposing upon the earlier Thulers, emanated from two distinct sources. One group was derived from people of Athapaskan stock as represented by the modern Chipewyans, characterized by moderate height, mesocephaly, wide heads and fairly long and broad faces; the other was of Algonkian origin, as represented by the Cree, showing very short stature, dolichocephaly bordering on mesocephaly, quite short and narrow faces, with low cephalo-facial indices.

The "Athapaskan Chipewyan" group traveled to the north and west, the western division occupying the region of Kotzebue Sound, Seward Peninsula and St. Lawrence Island, while the northern division, represented by the Copper Eskimos, migrated to the region of Coronation Gulf and Victoria Island.

The "Algonkian Cree" stock sent their numbers to the north and east in successive waves of migration. The first group occupied the whole territory of Hudson Bay, Labrador, Baffin Land and Greenland, supplanting still existing bands of Old Thulers. The second group, represented by the present Caribou Eskimo, at a later period invaded the Barren Grounds where they are to be found today.

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NATURE AND NURTURE IN RELATION TO TWINS AND BROTHERS IN WHO'S WHO

BY CLIFFORD KIRKPATRICK AND GRACE CEDARSTRAND

University of Minnesota

I.

The controversy concerning the relative importance of nature and nurture in its varied aspects has given rise to a vast literature and has introduced conflict into both debating societies and scientific conventions. Much of the confusion and disagreement has been due to dogmatism, false alternatives and lack of precision in the use of concepts. There is still a problem, however, and one which has perennial interest in view of its wide range of implications for biology, psychology, sociology and anthropology.

Certainly it is absurd in view of the writings of men like Child, Morgan and Jennings to assume that the heredity of an organism is an entity existing in a definite form independently of environment. Every trait of an organism whether structural or functional is a product of the interaction of the original cell and its derivatives, with the environment. There is no so-called hereditary trait which must appear regardless of environment.[1] Heredity is a concept derived from the observed fact that organisms may resemble each other though reared in different environments and differ from each other although reared in apparently the same environment. It is assumed by many that these differences and resemblances are due to differences in the genes of the original fertilized cells. The validity of this assumption obviously depends upon certainty of difference or identity of environments. Heredity is the potentiality of genes as manifested in resemblances in different environments and differences in the same environment. It is an abstraction inferred from an assumed impotence of environment to explain certain resemblances and differences.[2] Obviously it may refer to

[1] Jennings, H. S. The Biological Basis of Human Nature. W. Norton Co., *N. Y.*, 1930.

[2] Kirkpatrick, C. Intelligence and Immigration. Williams and Wilkins, *Baltimore*, 1926, pp. 7-14.

specific rather than general traits but unless differences and resemblances cut across the channels of environmental influence the concept of heredity by very definition cannot be invoked. The importance of heredity so conceived can best be weighed against that of environment for specific traits such as eye color, I. Q., insanity or status as a person of achievement. But by what methods and standards can the relative importance of nature and nurture be determined?

(1) One possibility is to compare the maximum variation in the resemblance or difference of traits that could be produced by a maximum variation of either genes or environment, the other factor remaining constant. The outcome of such a hypothetical comparison would vary with the trait under consideration but certainly death can be produced by lethal genes or lethal environment. There is reason to think that a child may be feeble-minded in the ordinary environment if it develops from a cell containing certain genes but it will also be feeble-minded if brought up in a barrel or if treated with certain drugs. Perhaps heredity is a little more potent in producing resemblances in the average environment than is the environment in moulding individuals with average genes to identity. It is hard, for example, to see how environment could make non-identical twins into identical twins. Nevertheless, the answer as to the relative potency of nature and nurture will vary with the particular genes and the particular environment which are in interaction and will not be in quantitative terms.

(2) In the second place there is the possibility of obtaining an answer or rather answers by statistical methods of correlation as used by Burks, Freeman, Sims and others.[3] It is possible, for example, to compare the correlation of I. Q. of child and intelligence of relatives with the correlation of I. Q. of child and various environmental conditions. There is evidence of some stability of natural family resemblances, and of resemblance between child and members of a foster family, but it is not so certain that percentage influence can be allotted to heredity and environment on such a basis, or that the influence of one factor can be expressed as a multiple or a sub-multiple of the other. It

[3] Burks, Barbara S. The relative influence of nature and nurture upon mental development. *27th Yearbook, National Society for the Study of Education*, pp. 247-316; Freeman, F. N., and others. The influence of environment on the intelligence, school achievement, and conduct of foster children. *27th Yearbook*, pp. 103-218; Sims, V. M. The influence of blood relationship and common environment on measured intelligence. *J. Educ. Psychol.*, 1931, *22*, pp. 56-65.

should be noted (1) that there is no evaluation of nature and nurture in the case of the individual, (2) that constancy of resemblance is shown only for the limited measurable range of environmental variation, and (3) the possible differential influence of equal increments of environmental improvement on different levels of endowment is obscured by the statistical treatment.

(3) The problem here under discussion is similar to that offered by the economic factors in production. Which is more important, labor or capital, in creating a given amount of product? Obviously the importance of any one factor depends on its amount in relation to the amounts of other factors. It is possible for the economist to work out a marginal productivity theory and to argue that the value of a unit of labor is the increased product due to that unit, other factors being constant and that this value is in proportion to the relative scarcity of labor. It is probably true that a child with an I. Q. of 150 living in poverty and isolation would profit more by a year's schooling than would a child with an I. Q. of 50 already surrounded by tutors. In one sense both heredity and environment each have their importance determined by their ratios to each other and yet quantitative units to express these ratios are lacking, at least in the case of heredity. It is certainly impossible to add or subtract a gene making for intelligence and to note its marginal productivity in achievement.

As a preliminary to presenting a tentative study of rôles of heredity and environment in producing men of achievement certain conclusions may be ventured then as to evaluation of the general importance of these two factors. (1) Heredity and environment cannot be separated. (2) It is impossible to evaluate the relative importance of nature and nurture in the case of a single individual. (3) Heredity is known through resemblances and differences not readily explainable by environment, but it is impossible to compare the influence per unit of heredity with influence per unit of environment. At most, certain quantitative variables, perhaps degrees of relationship, can be taken as rough indices of the heredity factor. (4) In the last analysis there are an infinite number of unique problems as to relative potency of nature and nurture depending on the trait under consideration, the form of variation of the nature and nurture factors, and the ratios of the degree of variation of each factor from the norm. (5) There can be no true and direct quantitative comparison of the potency of nature and nurture, but merely observation of the effects of particular qualitative variations and an esti-

mate on a pragmatic basis of the probable stability of resemblances and differences under certain particular conditions.

II

With these preliminary considerations in mind attention may be turned to the more specific problem of the rôles of heredity and environment in relation to achievement as measured by inclusion among a list of notables. Many years ago Francis Galton showed that eminence runs in families and that about half of the eminent men have one or more eminent relatives. Some 13 per cent of the brothers of eminent men were also eminent while in the case of brothers of men of science the proportion amounted to almost 50 per cent.[4] F. A. Woods presented evidence to show that the tendency holds true in more democratic America.[5] Cattell found that the professional classes contributed some 14 times their quota to *American Men of Science,* a result quite in accordance with the findings of Ellis, De Candolle, Odin, Clarke and Brimhall.[6] Visher found that in proportion to numbers the professional classes contributed almost 1,400 times as many persons to *Who's Who* as did the unskilled laborers.[7]

Without assuming the extreme environmentalist position of Ward it may be pointed out that according to our preliminary analysis no convincing proof is offered in these studies of the influence of heredity.[8] The striking resemblances in achievement are associated with resemblances in favorable environment and the differences in achievement with differences in environment. A somewhat better control of environmental factors exists when the tendency of twin brothers to both get in *Who's Who* is compared with the tendency of ordinary brothers to resemble each other in achievement as measured by this criterion. It is such a comparison which is attempted in this study. The question is, does an increasing similarity of germplasm mean an increasing resemblance in achievement?

[4] Galton, F. Hereditary Genius. The Macmillan Co., *London,* 1892, pp. 309-324.

[5] Woods, F. A. Heredity and the hall of fame. *Popular Science Monthly,* May 1913, pp. 445-452.

[6] Cattell, J. M. Families of American men of science. *Popular Science Monthly,* 1915, 86, pp. 504-515.

[7] Visher, S. S. A study of the type of the place of birth and of the occupation of fathers of subjects of sketches in Who's Who in America. *American Journal of Sociology,* Vol. 30: 5: March, 1925, pp. 551-557. See also Visher, S. S. Geography of American notables. *Indiana University Studies,* Vol. 15, No. 79, 1928.

[8] Ward, L. F. Applied Sociology. Ginn and Co., *N. Y.,* 1906.

A subtraction of feminine names revealed that there are 28,564 men listed in *Who's Who* for 1930-31. The average age at entrance into this volume is 51 years.[9] It was found from a random sample of 244 male names that the average age of these men was 61.1 years. It would seem fair therefore to refer the *Who's Who* population to the general male population 45 years of age and over which according to the 1930 census includes 14,496,280 persons.[10] This means that the chances of a person in this age and sex group being listed in *Who's Who* are 1 in 507.5.

Rather more assumptions are involved in calculating the chances of a person listed in *Who's Who* also having a brother listed. In the first place how many living brothers who might get into *Who's Who* may be assumed per brother actually listed? The answer will depend on the size of families some sixty years ago and upon the average mortality rates since that time. Cattell found that the parents of American men of science had about 4.7 children on the average.[11] The grandparents of Newcomb college students had on the average 5.37 children of whom 4.73 survived to adult life.[12] Hewes found at Mount Holyoke that the grandparents of students had on the average 4.97 children of which 65 to 70 per cent survived.[13] Ross and Baber found that the parents of students came from families which averaged 5.44 children.[14] Further evidence might be cited but it seems a reasonable assumption that men of an average age of 61.1 years listed in *Who's Who* are on the average, members of five sibling families with 1.5 brothers.

The number of the brothers who would be likely to survive to a time such that the brothers listed in *Who's Who* averaged 61 years of age would depend somewhat upon the relation between achievement and birth order. Cattell found a tendency for American men of science to be first born but the trend of the evidence collected by Thurstone, Hsiao,

[9] Who's Who 1930-31, p. 7.

[10] Statistical Abstract of the U. S. 1931, p. 5.

[11] Cattell. Families of American men of science. *Scientific Monthly*, Vol. 5, 1917, pp. 368-377.

[12] Gould, H. N., and Davis, B. Size of family. *Journal of Heredity*, 1930, 21, pp. 489-494.

[13] Hewes, Amy. Note on the racial and educational factors in the declining birth-rate. *American Journal of Sociology*, Vol. XXIX, No. 2, Sept. 1923, p. 180.

[14] Ross, E. A., and Baber, R. E. Slow suicide among our native stock. *Century Magazine*, Feb. 1924, pp. 504-509.

and Jones would seem to indicate that such a relationship is not likely to be an important factor in the present instance.[15]

Assuming then, an average of 1.5 brothers for eminent men how many of these brothers will survive to be exposed to selection for *Who's Who*? If it is assumed that order of birth is unrelated to achievement it would be legitimate to assume that surviving brothers of persons listed in *Who's Who* would also average about 61 years of age. They are men who survived the risks of six decades which eliminated a certain proportion of those born as brothers to men later attaining eminence. According to the data from the Registration Area of the United States in 1910 constructed into a life table diagram 50 per cent of a group born at one time would be dead 60 years later.[16] It is probable that the expectation of life was somewhat less about 1870 when the average person listed in *Who's Who* was born. It is also true, however, that such persons come from the higher social classes which presumably have a lower death rate than is found in the United States as a whole. It seems reasonable to assume that men listed in *Who's Who* for 1930-31 will on the average possess as a statistical abstraction .75 of a living brother. This corresponds to a whole brother apiece for 75 per cent of the men in *Who's Who*.

The next problem is to find what proportion of men listed in *Who's Who* have these living brothers also listed. It was decided to sample every tenth page of the volume beginning at page 133 but continuing 140, 150, 160, 170, etc. The first male name on each page was taken and the names of both parents were noted. A search often exceedingly laborious was then made among the sketches of other males of the same name for those having the same parents as the persons in the sample. The names of parents were given in almost every case so that this check was possible.

There were names of 231 men in the sample and of these 11 had one brother also listed and 1 had two brothers listed. This means that the

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[15] Thurstone, L. L., and Jenkin, R. L. Birth order and intelligence. *J. Educ. Psychol.*, 1929, Vol. 20, pp. 641-651.

Hsiao, H. H. The status of the first-born with special reference to intelligence. *Genetic Psychology Monographs*, Vol. 9: 1 and 2, 1931.

Jones, H. E. Order of birth in relation to the development of the child *in* Handbook of Child Psychology. Clark University Press, *Worcester*, 1931, pp. 204-241.

[16] Pearl, R. The biology of death III—The chances of death. *Scientific Monthly*, Vol. XII, No. 5, May 1921, p. 445.

chances are 1 in 19.25 that a man in *Who's Who* has one or more brothers also listed. It may be assumed that having two brothers rather than one brother in *Who's Who* does not greatly affect one's likelihood of being listed, and that on the average 75 per cent of the sample or 173 men have living brothers. Having a brother in *Who's Who* then gives one a chance of 13 in 173 at eminence or 1 in 13.3 as compared with 1 in 507.5 for the general male population over 45. It may be objected that the sample of 231 or, more conservatively, 173 names is too small to be representative of the entire 28,564 names. If the appropriate formula be applied, in this case $\sigma_p = \sqrt{\frac{pq}{n}}$, it is found, however, that the chances are 68 out of a hundred that other samples of 173 would yield probabilities between 1 in 10.9 and 1 in 19.3. The chances are 9,973 out of 10,000 that the true proportion is between 1 in 7.6 and 1 in 85.4. There is obviously an advantage to those with brothers in *Who's Who* as compared with the general population.

The next problem as to the resemblance of twin brothers in eminence involves rather more assumptions and a more complicated chain of reasoning. How many men listed in *Who's Who* have twin brothers living who might also be listed? Statistics vary somewhat as to the proportion of twin births among total births. Dahlberg, dealing with European data, cites numerous authorities according to whom the proportion of twin births varies from 1 : 90 to 1 : 80.[17] Williams cites Prussian statistics based on 13,000,000 cases showing a ratio of 1 : 89.[18]

According to the births of 1917 in the United States Registration Area it is estimated that the proportion of twins is 1 : 93.[19] In 1920 in the same area there were 1,492,532 births of which 17,229 were twin births yielding a ratio of 1 : 87.[20] A recent study of 75,000 school children revealed 1051 twins or a ratio of 1 : 71.4.[21] It seems reasonable to assume a proportion of 1 in 87 as the most probable figure bearing in mind the ratios 1 : 93 and 1 : 71 as minimum and maximum. Assuming no differential mortality one would expect about 1 in every 87 of the

[17] Dahlberg, Gunnar. Twin Births and Twins from a Hereditary Point of View. Bokforlags—A. B. Tidens Tryckere, *Stockholm*, 1926, pp. 9-10.

[18] Williams, J. W. Obstetrics. D. Appleton & Co., *N. Y.*, 1930, p. 433.

[19] Hirsh, N. O. M. Twins: Heredity and Environment. Harvard University Press, *Cambridge*, 1930, p. 19.

[20] U. S. Census Report 1920.

[21] Wilson, T. P., and Jones, H. E. A study of like-sexed twins. HUMAN BIOLOGY, Vol. 3, 1931, pp. 107-132.

men in *Who's Who* to be twins. The proportion who have twin brothers would be about a third of the total. Newman found 234,497 male twins, 264,098 mixed twins and 219,312 female twins in his sample.[22] In the study of Wilson and Jones 28 per cent rather than a third of the pairs were both male. To assume the ratio of 1 : 3 therefore probably over-estimates rather than under-estimates the expected number of male twins in *Who's Who* with twin brothers. Upon this assumption 1 in every 261 of the men in *Who's Who* would have had at some time a twin brother. But how many of these twin brothers would live to the average age of 61 found for the *Who's Who* population? The fairest assumption would be the one made for ordinary brothers, namely that one-half the brothers would have died, thus breaking on the average one-half of the twin pairs. This would mean then that 1 in every 522 men listed in *Who's Who* would be expected to have a living twin brother who might get into *Who's Who*.

Applying this assumed ratio to the male population of 28,564 one would expect to find 55 men with living twin brothers. If the chances were absolute certainty that if one twin brother got in the other would also be included in *Who's Who*, then there would be 27 or 28 pairs of twin brothers found in the volume. As a matter of fact a laborious and careful check of each male name in the book for identical surname, parentage, date and place of birth revealed 9 pairs of twin brothers. This means that the chances are about 1 in 3 of getting into *Who's Who* if one's twin brother is listed.

This estimate of course rests on assumptions but they do not seem unreasonable. There is no reason to think that the mere fact of being a twin *per se* means greater intelligence or a greater chance of getting into a list of notables. If the maximum proportion of twin births is assumed corresponding to that found among school children, namely 1 : 71, then the number of twins with living twin brothers expected would be 67. This would mean a chance of 1 in 4 of a twin brother also being listed rather than 1 in 3. This ratio is still strikingly higher than in the case of ordinary brothers. One would not expect the various sources of error to always work in the same direction. For example, assuming 28 per cent as the proportion of male twins the final result would be shifted back in the direction of 1 : 3.

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[22] Newman, H. H. The Biology of Twins. The University of Chicago Press, *Chicago*, 1917, p. 9.

It may be properly argued that a ratio based on a theoretical sample of 55 cases is not very reliable since the addition or subtraction of one or two pairs of twins would make a good deal of difference in the result. Applying the formula previously used in a similar check upon the sample of brothers the chances are 68 out of a hundred that a proportion of 1 : 3 based on 55 cases is really not more than 1 : 2.5 nor less than 1 : 3.7. It would seem that having a twin brother in *Who's Who* gives one about four times as good a chance of being listed as having an ordinary brother included in this collection of alleged notables. The chances are about 168 times those of the general male population over forty-five years of age.

The next problem which presents itself is to explain the rather striking differences between the probabilities of resemblance in achievement between ordinary brothers and twin brothers. The possibility of influence of an age factor at once comes to mind. In 1931 the 18 twins were a trifle younger than the brothers, having an average age of 58 rather than 61. It might be argued that the mortality would not be quite as high for the twins as the brothers but this error could not be very great and might be non-existent if the ages of all twins in *Who's Who* were known. A more significant possibility is that the discrepancy in the age of brothers might have lowered their resemblance in achievement. In the case of the pairs of brothers in the *Who's Who* sample the average age difference was 7.3 years. It might be argued that men listed in *Who's Who* had brothers too young to be listed and to have their age differences thus recorded.

It would be desirable, in view of the small sample of brother pairs, to know the average age discrepancy of siblings in general or more usefully the normal age discrepancy in sibships of the same size as the sibships contributing men to *Who's Who*. As a rough check the average age discrepancy of siblings in completed families described in Judge Baker Foundation Case Studies was calculated. There were on the average 4.5 living children in these families and the average of the age differences of each sibling in relation to each other sibling in the same family was 6.7 years, based on 109 age discrepancies. The standard deviation of the age differences was 4.45 years.

It would seem that a probable average age difference of 6 or 7 years would not greatly affect the achievement resemblance record of brothers as compared with twin brothers. The sample of the *Who's Who* population is a mature group with an average age of 61. Assuming no effect

of birth order as such on achievement it would be expected that the brothers of men listed in *Who's Who* would also average about 61 years of age, and for the most part would be old enough to command recognition. The standard deviation of the ages of the *Who's Who* sample of 244 men is 11.3 years and of course a certain number would be below 51, the average age at entrance to *Who's Who*. As a matter of fact by actual count 20 per cent of the men in the sample of the *Who's Who* population were below 51 years of age. It is probable that about 20 per cent of the brothers of men in *Who's Who* would also be below the average age at entrance to *Who's Who*. That in itself is not significant in this comparative study, for a group of men whose brothers were twin brothers would also have about 20 per cent of their brothers below the average age at entrance, and yet there would be no age discrepancy factor to affect resemblance in achievement.

Do the younger men listed have any considerable number of still younger brothers who might raise the rate of resemblance of brothers in achievement as compared with twin brothers, were it not for their unequal maturity? The problem involves the resemblance of brothers in age. If there were no age correlation whatsoever, the 20 per cent of younger men in *Who's Who* would tend to have only 20 per cent of their brothers also under 51 years of age, yielding a 4 per cent chance that a brother in *Who's Who* would be under 51 and that having a brother this brother would also be under 51 years of age. Assuming on the other hand, an age correlation of ordinary brothers approaching that of twins, almost all of the brothers of men listed who are under 51 years of age would be under 51 years of age, but only 10 per cent on the average of the unlisted brothers would be younger than their siblings who were listed. With an imperfect age correlation inferable from the average age difference of 6 or 7 years, the chances would increase that the brothers of the younger men listed would be older rather than younger and thus have an equally good or better chance of being listed.

Even if it were granted that 10 per cent of the brothers of men in *Who's Who* failed to be also listed solely because of their youth, the proportion of 1 in 13 altered by 10 per cent would not approach very closely the proportion of 1 in 3 which expresses the chances of being in *Who's Who* if a *twin* brother is listed.

It might also be suggested that twin brothers would be more likely both to get in *Who's Who* because their same age and environment would tend to bring them into the same occupation. Of the 9 pairs of

twins 4 were in identical and 2 in similar occupations. Of the 12 brother sibships 3 showed brothers in identical occupations and 3 showed brothers in similar occupations. Even if this difference were more than chance there would be the possibility that the greater occupational resemblance of the twins was based on hereditary similarity of ability and temperament.

It must be granted, of course, that there are many assumptions in the structure of reasoning that has been built up, but it does seem probable that there is really a differential similarity of achievement between brothers and twin brothers which challenges explanation in terms of either heredity or environment or some combination of the two factors. Where differences exist and environment is identical then by very definition, hereditary differences based on differences in the germplasm must exist. In the present instance we are dealing with differences in degree of resemblance. The hereditarian hypothesis would be that twins resemble each other in achievement more than ordinary brothers because of greater similarity on the average of their germplasm. The presence of identical twins developing from the same fertilized ovum contributes to the resemblance of the two groups. It must be granted that such a theory fits into a conceptual framework of scientific facts and relationships. The implied chain of reasoning is somewhat as follows: The mechanism of heredity is known in animals subject to experimentation. Microscopic techniques show that there is a correspondence between chromosomes containing hypothetical genes and the appearance or non-appearance of certain physical traits. It is fairly certain that twins among the lower animals which have remarkably similar physical traits develop from the same fertilized ovum and have practically the same assortment of chromosomes. It is reasonable to assume that the physical similarity is due to the similar germplasm perhaps for some 93 per cent of the bodily characteristics.[28] Human twins are part of the organic world and from the evolutionary point of view have many physiological processes in common with other mammals. Certain pairs of human twins show remarkable similarity in physical structure, a resemblance not readily explainable by ordinary known environmental conditions. It is reasonable to assume for them also a similar germ-

[28] Newman, H. H. Twins and the relative potency of heredity and environment in development. *Publications of the American Sociological Society*, Vol. XVII, p. 51 ff.

plasm based on a similar uniovular origin.[24] Accepting the usual theory of sex determination, it would be expected that about half of the like sexed human twins would be identical twins of monozygotic origin. The final step in the chain of reasoning rests on evidence that physical similarity is associated with similarity in general somato-psychic behavior including the psycho-verbal behavior identifiable with thought and the so-called intellectual processes.[25] Thus the chain of reasoning runs from observable chromosomes to complex behavior. Lange has shown that identical twins show vastly greater similarity in regard to criminality than ordinary twins. Is it not probable that twins resemble each other in achievement to a greater extent than brothers because they contain within their number pairs of identical twins whose genes are more similar than those of brothers or ordinary twins?

This plausible hypothesis as applied to the present study would demand that some of the twins found in *Who's Who* should be identical twins and would be most acceptable if a subtraction of identical twins left the ratio of resemblance in achievement of fraternal twins the same as that for brothers. A brief questionnaire was sent to the 9 pairs of twins found in *Who's Who* inquiring as to degree and constancy of resemblance, confusion of family and others as to identity and their own estimate of their status. Obviously no such long distance diagnosis should be taken too seriously, but it did seem quite certain from the 18 replies that only four out of the nine pairs were identical twins. Ruling out these four pairs there remain five pairs out of a possible 27 both of whose members are listed in *Who's Who*. Assuming that there is some-

[24] See Brintle, S. L. Mental and physical measurements of a set of twelve-year old quadruplets. *J. Genetic Psychology*, Vol. 39, 1931, pp. 91-112; Clarke, A. E., and Revell, D. G. Monozygotic triplets in man, *J. of Heredity*, Vol. 21, 1930, pp. 147-156; Gesell, Arnold. Mental and physical correspondence in twins, *Scientific Monthly*, April, 1922, pp. 305-331, 415-428; Hirsch, N. D. Twins: Heredity and Environment. Harvard University Press, 1930; Newman, H. H. Studies of human twins. *Biological Bulletin*, Vol. 55, 1928, pp. 283-297 and 298-315.

[25] Bakwin, R. M. Similarities and differences in identical twins. *J. Genetic Psychology*, Vol. 38, 1920, pp. 373-397; Burr, C. W. Identical twins with identical personalities. *Archives of Neurology and Psychiatry*, Vol. 23, 1930, pp. 1285-1288; Gesell, A. The developmental psychology of twins, *in* Handbook of Child Psychology. Clark University Press, 1931, pp. 158-203; Lange, Johannes. Crime and Destiny. Charles Boni, 1930; Merriman, Curtis. The Intellectual Resemblance of Twins. Psychological Monographs, Vol. 33, No. 5, Whole No. 152, 1924; Richmond, Winifred. The psychic resemblances in identical twins. *American Journal of Psychiatry*, Vol. 6, 1926, pp. 161-174.

thing more than a coincidence where such small numbers are involved, there seems justification for a hypothesis that environment contributes something to the resemblance of fraternal twins in achievement as compared with brothers and perhaps to that of identical twins.

It would be possible to frame a variety of specific hypotheses on the general assumption that the differences in resemblance of twins and brothers are due, at least in part, to differences in the resemblances of the environments of the two groups. It might be suggested that twins dress alike, are identified with each other by persons outside the pair and develop a corresponding joint conception of themselves and their rôles which involves the acceptance of such a social identification. One might consider the possibility of a status rivalry which would force upon each twin the duty of maintaining a parity of achievement. The most plausible environmentist hypothesis is to assume an influence from a combination of environmental factors. Certainly very interesting hypotheses can be framed and the process of personality development among twins is worthy of investigation by the social psychologist.

It was previously argued that there can be no final answer to the general nature-nurture problem. At the end of our quest we have found nothing to contradict that proposition. As usual one is faced with the ultimate problem as to weight of evidence and as to where the burden of proof should be placed. Until environment can be kept absolutely constant this problem will persist.

There remains only the task of pointing out certain scientific precautions in the interpretation of results such as ours. A hypothesis is necessary for intellectual orientation and according to the usual canons of scientific method, there should be a tentative acceptance of the simplest hypothesis which accounts for all of the observed facts and paves the way for further investigation. The objective paths of science sooner or later lead to the realm of values and opinion. It should be strongly urged, however, that the allocation of the burden of proof is an excellent index of prejudice. It is only reasonable to judge a hypothesis in terms of its alternative. To deny a hypothesis because it is not the only conceivable hypothesis or because proof is not overwhelming, is legitimate but it puts an obligation upon the sceptic. A denial implies either an alternative hypothesis or mere confused negativism. It seems biased and illogical to deny a hypothesis because the proof is not perfect and then with a complacent air of scientific virtue to believe the opposite without concern for evidence in support of this implied negative

hypothesis. Both hereditarians and environmentalists could well be less generous in passing the burden of proof and strive for a more happy egalitarian marriage of fact and hypothesis.

OBSERVATIONS ON THE GROWTH, CLASSIFICATION AND EVOLUTIONARY SPECIALIZATION OF GIBBONS AND SIAMANGS (*Concluded*)

BY ADOLPH H. SCHULTZ

Laboratory of Physical Anthropology, Johns Hopkins University

CHAPTER 5. GROWTH

The changes with advancing growth in body proportions and other features have been studied in material consisting of 69 embalmed gibbons and siamangs, ranging in age from embryonic to adult life.[6] These specimens are listed in tables VI and VII, which contain information regarding species, size, approximate age, sex, and ownership of the material. The entire span of growth has been divided into 9 more or less arbitrary periods to facilitate a grouping of the specimens according to their approximate ages. The first fetal period contains small fetuses from about 25 to 65 mm. sitting height, the second period fetuses up to 110 mm. long, and the third period all the largest fetuses including those near full term. Newborns and infants, a few months of age, represent the period "infant I." "Juvenile I" specimens have at least all deciduous teeth and the first permanent molars, whereas "juvenile II" specimens range up to the developmental stage with all permanent teeth, except the third molars. Table 20 shows the distribution of this material in the different age periods and is intended as a key for finding the number of the specimens in subsequent tables. It is regrettable that only 13 of the 69 available Hylobatidae in the flesh are of the specially important and interesting prenatal periods, and that no adult preserved specimens of *Hylobates* (*Brachitanytes*) *klossi* could be studied.

The exact technique for measuring the outer body of primates has been described in full detail in a special paper by the author (1929). For an explanation of the various measurements discussed in this chapter on growth the reader must be referred to the just mentioned publication.

[6] After this paper had been written the author was able to measure, with the kind permission of Dr. G. B. Wislocki, the perfectly preserved fetus of *Hylobates concolor* in the Anatomy Department of Harvard University. This specimen is listed as No. 4*a* in the tables 20 and VI.

TABLE 20

Distribution of Preserved Specimens According to the Different Age Periods. Specimens in the Same Perpendicular Column are of Approximately Corresponding Developmental Stages. The Numbers Refer to the Running Numbers of the Specimens as Listed in the Tables VI and VII. In All Subsequent Tables on Growth Changes the Specimens are Arranged in Exactly the Same Manner. Of the 9 Adult H. pileatus and the 8 Adult S. syndactylus Only the Averages and the Minimum and Maximum Values will be Given. The First Column is Omitted in Some of the Later Tables Because Some Measurements Could Not be Taken on the Single Available Specimen of That Age Period.

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT	
	1	2	3	4a	7	9	10	11	12	
H. concolor	..	..	4	5	8	..	..	..	..	
	..	..	..	6	..	..	..	..	..	
	..	..	..	..	13	..	14	15	18	
H. lar	..	..	..	..	..	..	..	16	19	
	..	..	..	..	..	..	..	17	..	
H. cinereus	..	..	..	..	..	..	20	..	23	
	..	..	..	..	..	..	21	22	24	
	..	..	25	27	29	..	..	..	Min.	33
H. pileatus	..	..	26	28	..	30	31	32	Aver.	to
	..	..	..	..	..	..	..	..	Max.	41
H. agilis	..	..	..	..	..	42	43	44	..	
H. leucogenys ...	..	..	..	..	45	..	46	47	48	
	..	..	..	..	..	..	..	..	49	
H. klossi	..	..	..	50	51	52	53	..	..	
	..	..	..	54	55	56	57	59	Min.	61
S. syndactylus	..	..	..	..	..	..	58	60	Aver.	to
	..	..	..	..	..	..	..	..	Max.	68

K. Ischial Callosities

In a former paper (1927) the author discussed in some detail the difference in the development of the ischial callosities between lower catarrhines and gibbons. It was found that in the former these callosities appear earlier in fetal life than the lanugo of the caudal end of the trunk, whereas in the latter the lanugo develops first, to be followed by a loss of hair in the zones to be occupied subsequently by the callosities. Ontogenetically, therefore, the callosities develop much later in gibbons than in lower monkeys.

TABLE 21

The Age Changes in the Skin Overlying the Ischial Tuberosities, Leading to the Appearance of Horny Ischial Callosities. The Numbers in Parentheses Refer to the Running Numbers of the Specimens, as Listed in the Tables VI and VII. S. H. = Sitting Height of Specimen. None of the Specimens Younger Than Age Period "Fetus III" Showed Lanugo or Callosities and All Specimens Older Than Age Period "Infant II" Had Well Developed Callosities.

	SKIN OVERLYING ISCHIAL TUBEROSITIES BEARS IN:		
SPECIES	FETUS III	INFANT I	INFANT II
H. concolor	(5) S. H. 149 mm. fine, sparse hair (6) S. H. 161 mm. fairly dense coat of lanugo	(7) S. H. 179 mm. small horny callosities (8) S. H. 207 mm. horny callosities	(9) S. H. 237 mm. large callosities
H. lar		(13) S. H. 173 mm. small horny callosities	
H. pileatus	(27) S. H. 158 mm. complete coat of lanugo (28) S. H. 169 mm. hair-free zones, no callosities	(29) S. H. 198 mm. small horny callosities	
H. agilis			(42) S. H. 252 mm. large horny callosities
H. leucogenys		(45) S. H. 188 mm. fine, sparse hair surrounded by denser hair	
H. klossi	(50) S. H. 145 mm. fine, sparse hair of complete coat of lanugo	(51) S. H. 203 mm. fine, sparse hair surrounded by denser and longer hair	(52) S. H. 211 mm. faint indication of callosities but still a few hairs
S. syndactylus	(54) S. H. 168 mm. fine, sparse hair	(55) S. H. 181 mm. few, fine hairs, no trace of callosities	(56) S. H. 285 mm. hair-free zones but no callosities

With the new data on many additional specimens (Table 21) it has become possible to state that the time of development of the ischial callosities varies individually a good deal among the gibbons, but occurs always comparatively late in growth. The author has examined a great many older fetuses of catarrhine monkeys in which the callosities were

invariably already present, but he has never seen a *fetus* of the Hylobatidae in which these structures have as yet made their appearance. Before birth gibbons possess at most small hair-free zones overlying the ischial tuberosities. This is the case in the nearly full-term fetus of *H. pileatus* (No. 28) and in the large gibbon fetus described by Deniker (1885). As shown by Table 21, horny callosities can appear very rapidly after birth, since they are already found in specimens with sitting heights of only 173 and 179 mm. (Nos. 7 and 13) which could hardly have been more than two to three weeks old. In the larger (S. H. 188 mm.) *H. leucogenys* (No. 45), known to be four weeks old, the later callosities are merely indicated by the fact that the hair overlying the ischial tuberosities is not nearly as dense as on the surrounding region. In *H. (B.) klossi* and in *S. syndactylus* the callosities are not yet developed even in the "infant II" period, but are present in all juveniles that have been examined. It is very significant that a siamang (No. 56) with a sitting height of 285 mm. and all his deciduous teeth has reached only the stage of hair-free zones, which precedes the stage of the actual development of callosities, whereas a gibbon with a sitting height of only 173 mm. and with but two milk incisors erupting has already horny callosities.

These observations confirm the previous conclusions that the Hylobatidae represent in many ways a transition from lower catarrhines to the anthropoid apes, and that the siamang has approached the latter somewhat more closely than have the gibbons. In contrast to frequent assertions in the literature and as the author has demonstrated before (1927), the large apes, notably the chimpanzee and the orang-utan, do possess small, horny, ischial callosities in occasional individuals. As in the siamang, they do not seem to develop until considerable time after birth.

The catarrhine peculiarity of ischial callosities shows a gradual trend toward disappearance among the higher primates, and has not become eliminated abruptly. This trend manifests itself by the late ontogenetic appearance of callosities in gibbons, by their still later postnatal development in *H. klossi* and the siamang, and by the sporadic[7] and also ontogenetically late occurrence of comparatively small callosities among at least two of the anthropoid apes.

[7] Since his compilation (1927) of data relating to ischial callosities in anthropoid apes the author has seen several new cases in which these structures are well developed. For instance, one of the three adult embalmed chimpanzees, collected

L. Ears

It has already been demonstrated by Schwalbe (1916) that the relative size of the gibbon ear increases markedly with advancing growth, small fetuses possessing a proportionately very much smaller outer ear than newborns and adults.

As shown by Figure 10, the edge of the helix does not begin to roll in until late in fetal life. This corresponds exactly to the growth changes in the ears of, *e. g.*, gorilla (Schultz, 1927) and of man. In adult Hylobatidae the edge of the helix is rolled in much more exten-

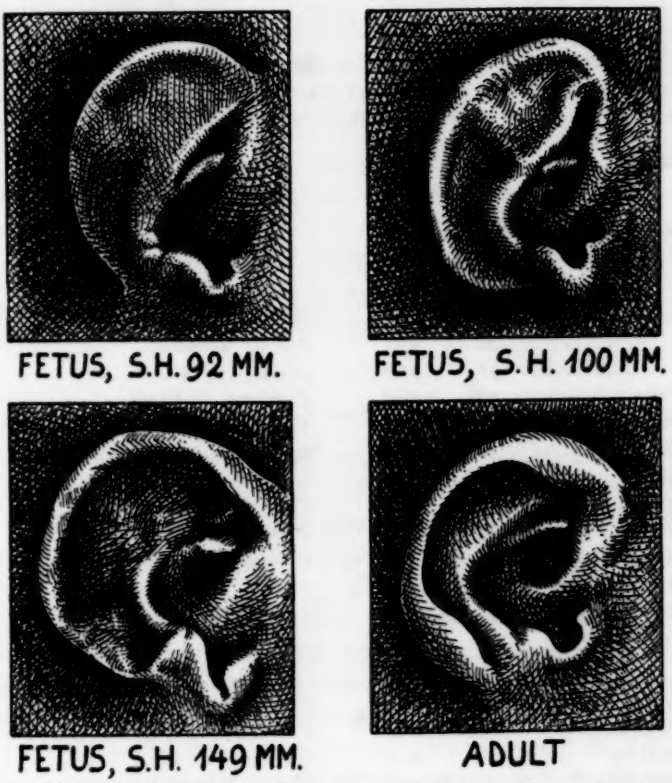

FIG. 10. FOUR DEVELOPMENTAL STAGES OF THE EAR OF HYLOBATES CONCOLOR (S. H. = SITTING HEIGHT OF FETUS)

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by the Columbia University—American Museum African Expedition, possesses large horny ischial callosities, which are unquestionably comparable to these structures in lower catarrhines.

sively than in catarrhine monkeys and somewhat more extensively than even in many anthropoid apes and men. The adult outer ear of the Hylobatidae shows various striking similarities to the ear of the orang-utan (see, *e. g.*, fig. 8 in the author's paper on primates, 1931). In the former, however, a lobule is never present, whereas among the latter a lobule exists in occasional specimens. In contrast to the great majority of the catarrhine monkeys, the Hylobatidae never show the pointed form of ear, in which there is a more or less sharp corner on the upper posterior edge of the helix. A so-called Darwinian tubercle has never been found on the ears of gibbons and siamangs.

TABLE 22

The Absolute and the Relative (Ear Height in Per Cent of Head Length) Height of the Ear in Adult Gibbons and Siamangs and, for Comparison, the Relative Height of the Ear in Some Adult Catarrhine Monkeys and Apes and Man (Species Names After Elliot, 1913).

SPECIES	EAR HEIGHT (mm.)	RELATIVE EAR HEIGHT	SPECIES	RELATIVE EAR HEIGHT
H. concolor	33	41.2	*Papio hamadryas*	40.3
H. lar	36	43.4	*Magus maurus*	41.7
H. lar	35	41.7	*Simia sylvanus*	46.9
H. cinereus	32	40.0	*Pithecus philippin.*	40.0
H. cinereus	36	40.4	*Cercocebus aethiops*	42.2
H. pileatus	32.5	39.2	*Lasiopyga pygeryth.*	47.3
H. pileatus	32.5	38.7	*Erythrocebus patas*	52.2
H. pileatus	34	39.5	*Pygathrix germaini*	48.8
H. pileatus	34	39.1	*Nasalis larvatus*	34.0
H. pileatus	33	38.8	*Colobus abyssinic.*	44.4
H. pileatus	35	40.3		
H. leucogenys	33	39.3		
H. leucogenys	36	38.3		
AVERAGE (*Hylob.*) ..	34.0	**40.0**		
S. syndactylus	29	32.2	*Pongo pygmaeus*	24.7
S. syndactylus	31.5	32.5	*Pan satyrus*	47.9
S. syndactylus	31	31.0	*Gorilla gorilla*	23.8
S. syndactylus	30	30.6	*Homo sapiens*	26.3
S. syndactylus	30	31.9		
S. syndactylus	29	30.5		
S. syndactylus	30	30.6		
S. syndactylus	32	32.3		
AVERAGE (*Symph.*) ..	30.3	**31.4**		

Schwalbe (1916) has discussed some differences in the detailed configuration of the ear between the siamang (only one specimen!) and the gibbons. In view of the marked variability of these features the writer does not believe that these differences are very significant. However, the tentative claim of Schwalbe that the siamang possesses a smaller ear than the gibbons is fully borne out by the present investigation. According to the figures in Table 22, which were all obtained from full-grown embalmed specimens, the height of the ear averages in gibbons 34 mm., whereas in the large siamangs only 30.3 mm. In percentage of the head length the ear height averages only 31.4 in the latter, whereas 40.0 in the former. This proportion is surprisingly constant and the ranges of individual variations are far apart, even though the series of gibbons is composed of five different species. The siamang, therefore, is characterized by a considerably smaller outer ear than occurs in any of the gibbons. As shown by the comparative data in Table 22, the lower catarrhines have in general somewhat larger ears than the gibbons, whereas the highest primates, with the exception of chimpanzee, possess proportionately smaller ears than even the siamang. Again, therefore, the Hylobatidae bridge a gap between the lower and the highest catarrhines and, again, the siamang is advanced farther from the condition in monkeys than are the gibbons.

M. Body Proportions

a. Trunk

Some body proportions remain practically constant throughout growth, whereas the majority of the proportions change in varying degrees with advancing age. Such changes are due to the fact that the two bodily dimensions of which a proportion is composed grow at different rates.

The percentage proportion between the chest circumference (at the level of the sternal ends of the fourth pair of ribs) and the height of the trunk (from suprasternal notch to upper edge of the pubic symphysis) expresses the degree of relative stoutness of the trunk. The values of this proportion in Hylobatidae of various ages are listed in Table 23. The relative chest circumference is always greater in prenatal than in postnatal stages of growth. In *H. concolor, e. g.,* the chest circumference amounts to 343 per cent of the trunk height in an embryo, whereas to only 151 per cent in an adult. It can be stated, therefore, that the trunk becomes in general more and more slender with advanc-

ing growth. That this is true in other primates as well, was shown by the author in a previous paper (1926). Some of the figures in Table 23 indicate the possibility of an occasional secondary increase in this proportion during juvenile life, since in some instances adults possess somewhat stouter trunks than some of the juveniles of the same species. Such a secondary "filling out" of the trunk is well known to take place in man after the age of about 25 years.

In regard to the relative chest girth there seem to exist some species differences within the genus *Hylobates*. In *H. leucogenys, e. g.,* the trunk is somewhat more slender than in *H. cinereus,* a difference which is found not only in adult life, but also already in the age periods "infant I" and "juvenile I and II."

The average relative chest circumference of the 8 adult siamangs amounts to 173.6 (maximum value = 204.6), whereas that of the 7 adult gibbons amounts to only 148.8 (maximum value = 154.5). The

TABLE 23

The Chest Circumference in Percentage of the Trunk Height

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	343.0	198.3	199.4	178.6	170.3	167.9	139.4	135.7	151.4
	....	....	178.2	180.5	151.8	....	....	....	....
	....	....	....	173.4	....	....	....	....	....
H. lar	....	....	....	....	168.6	....	151.1	156.2	149.5
	....	....	....	....	....	....	....	165.8	145.8
	....	....	....	....	....	....	....	137.0	....
H. cinereus	....	....	....	....	....	....	149.7	....	153.1
	....	....	....	....	....	....	164.0	140.2	154.5
H. pileatus	....	....	211.8	189.9	149.0	....	....	....	....
	....	....	185.9	195.1	....	....	....	....	....
H. agilis	....	....	....	....	....	154.0	148.0	140.2	....
H. leucogenys	....	....	....	....	149.5	....	137.3	135.5	142.4
	....	....	....	....	....	....	....	....	144.7
H. klossi	....	....	....	176.0	164.3	159.0	161.2	....	....
S. syndactylus	....	....	....	....	168.7	180.5	155.6	160.0	151.0
	....	....	....	....	....	....	154.8	181.4	173.6
	....	....	....	....	....	....	....	....	204.6

former, therefore, are characterized by a much stouter trunk than the latter, a conclusion which had been reached also by Moszkowski (1908), who states that siamangs are not only heavier but also plumper or stouter than gibbons. The significance of this generic difference within the family of Hylobatidae becomes evident by a comparison between the values for the relative chest circumference in all catarrhines. According to a preliminary report by the author (1931), this proportion averages 107.1 in adult Old World monkeys (ranging individually from 83 to 130), whereas 171.4 in chimpanzees, 181.1 in orang-utans, and 206.7 in gorillas. It is seen that the average values for gibbons (149) and for siamangs (174) stand between the averages of the lower and those of the higher catarrhines, and that the siamangs approach the anthropoids much more closely than do the gibbons. Indeed, the average siamang has a proportionately greater chest circumference than has the typical chimpanzee, and differs in this respect less from the orang-utan than from the gibbon.

TABLE 24

The Chest Breadth in Percentage of the Chest Depth

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	98.4	108.9	112.1	107.5	111.3	117.8	121.5	121.0	123.5
	....	....	105.9	114.2	120.0	....	....	....	....
	....	....	....	115.3	....	....	....	....	....
H. lar	....	....	....	....	118.9	....	111.0	119.1	118.4
	....	....	....	....	....	....	....	120.2	122.9
	....	....	....	....	....	....	....	118.4	....
H. cinereus	....	....	....	....	....	....	117.0	....	122.2
	....	....	....	....	....	....	113.0	112.8	114.8
H. pileatus	....	....	110.3	106.9	107.8	....	....	....	....
	....	....	111.0	108.8	....	....	....	....	....
H. agilis	....	....	....	....	....	119.9	115.5	114.7	....
H. leucogenys	....	....	....	....	107.2	....	114.2	114.3	111.3
	....	....	....	....	....	....	....	....	114.3
H. klossi	....	....	....	111.4	111.4	114.8	119.2	....	....
S. syndactylus	....	....	....	....	117.6	117.3	125.0	120.4	121.7
	....	....	....	....	....	....	123.8	123.8	124.8
	....	....	....	....	....	....	....	....	128.2

The shape of the chest is most accurately expressed by the percentage relation between the transverse and the sagittal diameter. The values for this proportion are listed in Table 24. In a former paper the author (1926) has demonstrated that in all embryos and young fetuses of primates the transverse chest diameter equals approximately the sagittal one, a cross section through the chest being roughly circular in shape. In a few of the catarrhine monkeys this relation between the two chest diameters remains almost unchanged throughout growth, whereas in all others the index decreases with advancing age, *i. e.*, the chest becomes proportionately narrower. In contrast to this, the chest index increases with growth in the Hylobatidae (see Table 24), in the anthropoid apes, and in man (Schultz, 1926 and 1927), so that these higher primates become distinguished in adult life by possessing unusually broad chests. According to the author's (1931) data the chest

TABLE 25

The Nipple Height (From Center of Line Connecting Nipples to Upper Edge of Pubic Symphysis) in Percentage of the Trunk Height

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	77.2	80.0	81.4	81.4	83.5	83.2	82.7	82.8	84.6
	....	....	80.4	81.2	81.9	....	....	....	....
	....	....	....	81.7	....	....	....	....	....
H. lar	....	....	....	....	80.2	....	82.4	84.8	85.2
	....	....	....	....	....	....	....	83.2	84.7
	....	....	....	....	....	....	....	83.7	....
H. cinereus	....	....	....	....	....	....	81.9	....	85.3
	....	....	....	....	....	....	81.3	82.3	85.1
H. pileatus	....	....	78.0	79.7	83.0	....	....	....	....
	....	....	78.0	81.7	....	....	....	....	....
H. agilis	....	....	....	....	....	84.0	86.5	82.9	....
H. leucogenys	....	....	....	....	79.4	....	80.9	82.9	82.8
	....	....	....	....	....	....	....	....	83.1
H. klossi	....	....	....	78.9	79.7	82.6	84.7	....	....
S. syndactylus	....	....	....	....	78.1	80.6	83.7	83.1	77.9
	....	....	....	....	....	....	83.3	82.3	81.2
	....	....	....	....	....	....	....	....	83.6

breadth amounts on an average to only 86.6 per cent of the chest depth in adult lower catarrhines, whereas to 124 in adult chimpanzees and in adult men, to 127 in adult orang-utans, and to 146 in adult male gorillas. According to the figures in Table 24 this percentage averages 118.2 in the 7 adult gibbons and 124.8 in the 8 adult siamangs. Again it can be concluded, therefore, that the Hylobatidae stand between the lower and the highest catarrhines (much closer to the latter than to the former) and that the siamang has evolved somewhat farther than the gibbon by having the proportionately broader chest of the two.

The exact position of the nipples on the anterior wall of the trunk differs a good deal among primates in later stages of growth, but it is comparatively uniform in young fetuses. In the course of growth this position shifts in a cephalic direction in most monkeys and apes, whereas in a caudal direction in man, who possesses nipples placed lower on the trunk than in any other adult catarrhines (see Schultz, 1926).

As shown by Table 25, the Hylobatidae behave in regard to the growth changes in the position of their nipples like the great majority of primates. In *H. concolor, e. g.,* the distance between the upper end of the pubic symphysis and the level of the nipples amounts to 77 per cent of the trunk height in an embryo, but to 85 per cent in an adult; in other words, the nipples have moved toward the suprasternal notch.

The index, expressing the position of the nipples, averages 84.4 in adult gibbons, but only 81.2 in adult siamangs. Both these values lie above the corresponding figures for most baboons and macaques (approximately 75 to 80), but below those for orang-utans (approximately 90 to 95). The figures for most other catarrhines lie between these extremes. It can be stated, therefore, that the nipples of the gibbons and the siamangs are situated neither unusually low nor exceptionally high, but that they lie somewhat higher in gibbons than in siamangs.

b. Limbs

The relative length of the lower extremity (great trochanter to knee joint + knee joint to sole in percentage of trunk height) differs markedly in different periods of growth. In man this relative limb length increases rapidly during the first part of fetal development, but decreases again before birth, and increases a second time during postnatal growth (Schultz, 1926). In the Hylobatidae this proportion seems to behave in a similar manner. As shown by the figures in Table 26, the relative leg length increases during one period of growth, but appears to decrease

again during a subsequent period. On account of the marked variability of this proportion the available material is still too scanty to show these growth changes in an unequivocal manner.

It is interesting to find that at least in adult life gibbons possess relatively much longer legs than siamangs. The relative leg length of the former averages 146.5 (varying individually to 153), whereas that of the latter only 131.4 (maximum value only = 139). The same proportion averages in adults 107 in catarrhine monkeys, 112 in gorillas, 118 in orang-utans, 128 in chimpanzees, and 167 in men (Schultz, 1931). These figures demonstrate that in regard to the relative length of the lower limb the Hylobatidae differ more from the lower catarrhines than do the anthropoid apes, and that the siamang stands nearer to the latter than do the gibbons. Among all simian primates adult man has the proportionately longest lower limbs. The gibbons rank second in this

TABLE 26

The Total Length of the Lower Limb (From Great Trochanter to Sole) in Percentage of the Trunk Height

SPECIES	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	104.5	139.3	140.6	163.8	169.5	140.7	144.1	148.4
	....	131.5	141.7	149.1	....	....	....	....
	....	....	137.3	....	....	....	....	....
H. lar	....	....	....	152.3	....	142.2	147.2	152.7
	....	....	....	....	....	....	150.3	149.3
	....	....	....	....	....	....	138.7	....
H. cinereus	....	....	....	....	....	152.2	....	144.8
	....	....	....	....	....	150.5	142.5	143.9
H. pileatus	....	130.8	136.7	138.6	....	....	....	....
	....	140.0	148.8	....	....	....	....	....
H. agilis	....	....	....	....	159.0	146.5	159.2	....
H. leucogenys	....	....	....	136.9	....	150.2	139.8	133.6
	....	....	....	....	....	....	....	153.0
H. klossi	....	....	137.2	144.3	136.3	158.0	....	....
S. syndactylus	....	....	....	113.6	143.7	125.7	131.5	122.0
	....	....	....	....	....	150.9	149.8	131.4
	....	....	....	....	....	....	....	139.0

respect. In individual cases the relative leg length of gibbons may even surpass that of some adult human beings. For instance, one adult *H. lar* and one adult *H. leucogenys* possess a relative lower limb length of 153, whereas in an adult Hawaiian of the Hopkins collection this index amounts to only 151. The maximum relative leg length of 169.5, found in an infantile *H. concolor*, surpasses the same proportion in a great many human beings.

The relative length of the upper limb (length of upper arm + length of forearm + length of hand in percentage of trunk height), as that of the lower limb, increases during the first part of growth, but seems to decrease again in many instances during subsequent stages of development (see Table 27). For instance, in *H. concolor* this proportion amounts to 143 in an embryo, to as much as 275 in an infant, but to only 239 in an adult. This indicates that during late postnatal life the trunk

TABLE 27

The Total Length of the Upper Limb (From Acromial Process to Tip of Middle Finger) in Percentage of the Trunk Height

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	142.7	181.5	221.1	220.0	267.5	275.0	223.0	223.2	239.4
	....	....	204.1	221.7	233.6	....	....	....	....
	....	....	....	221.5	....	....	....	....	....
H. lar	....	....	....	....	237.1	....	230.5	230.8	251.0
	....	....	....	....	....	....	....	238.0	241.3
	....	....	....	....	....	....	....	215.0	....
H. cinereus	....	....	....	....	....	....	246.2	....	219.0
	....	....	....	....	....	....	237.0	221.7	225.4
H. pileatus	....	....	206.7	212.8	210.9	....	....	....	....
	....	....	209.0	234.0	....	....	....	....	....
H. agilis	....	....	....	....	....	259.8	232.4	247.1	....
H. leucogenys	....	....	....	....	233.8	....	252.8	227.0	229.5
	....	....	....	....	....	....	....	....	259.0
H. klossi	....	....	....	216.1	202.2	203.0	242.7	....	....
S. syndactylus	....	....	....	....	202.1	251.2	221.8	234.2	221.0
	....	....	....	....	....	....	272.5	266.0	233.4
	....	....	....	....	....	....	....	....	254.6

grows more intensively than the limb, whereas at least during fetal life this relation is reversed.

The relative arm length of gibbons and of siamangs is practically the same; in adults it averages in the former 237.8 and in the latter 233.4.[8] These values are very much higher than the corresponding figures for any other adult primates. Even the Spider monkey has relatively much shorter arms (184) and only the orang-utan approaches the Hylobatidae in this respect with an average value for adults of 199.6. Adult chimpanzees have an average relative arm length of 173.5, adult gorillas (*Gorilla beringei*) one of 153.7, adult men one of 149.1, and adult catarrhine monkeys one of 119.3 (tentative range of species variations = 101 — 145) (Schultz, 1931). All higher primates have developed proportionately long upper limbs in contrast to the lower catarrhines, but the Hylobatidae are specialized in this respect much more extremely than any of the large apes. This is most likely connected with the fact that the gibbons and siamangs are the most perfect hangelers or brachiators of all primates.

For a proper interpretation of the significance of the lengths of the limbs they are studied not only in relation to the length of the trunk but also in relation to one another. This latter relation is obtained most accurately by expressing the arm length (upper arm + forearm) in percentage of the leg length (thigh + leg), a proportion which is practically the same as the intermembral index of the skeleton (see Table 16). As shown by Table 28, the relation between the lengths of the limbs undergoes some slight but significant changes in the course of growth. In *H. concolor, e. g.,* the arm length amounts to 132 per cent of the leg length in a young fetus, but to only about 116 per cent in fetuses close to term. In an adult the index has increased again to 128. During the first part of growth, therefore, the upper limb grows more slowly than the lower, but during later development this relation is reversed. The postnatal increase of the intermembral index is evident

[8] According to Mollison (1911) the total arm length in percentage of the trunk height (obtained by adding the averages of the separate percentage relations between the trunk height and each of the three main segments of the arm!) amounts to even more in the siamang, namely on an average to 246.6 in 29 specimens. For two adult *H. cinereus* Mollison's data result in an average of 230.0, a value which also surpasses the writer's corresponding figures for the same species. The most likely explanation of these discrepancies may consist in the fact that in measuring the trunk height Mollison did not straighten his animals to quite the same degree as does the writer.

in all the species of the Hylobatidae listed in Table 28. In four *H. leucogenys,* for instance, the index of the infant amounts to only 123.6, that of the juvenile to 132 and that of the parents of these two specimens to 139. As demonstrated in a former paper by the author (1930), an analogous postnatal growth change occurs in the orang-utan, whereas in chimpanzee and gorilla the intermembral index remains practically constant from birth to adult life. In man, on the other hand, this index decreases after birth, the total change being very much more marked than in any other primate.

TABLE 28

The Upper Limb Length (Upper Arm + Forearm) in Percentage of the Lower Limb Length (Thigh + Leg). The Figures Marked With an Asterisk are the Averages Based Upon Measurements on Skeletons (From Table 16)

SPECIES	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	132.0	120.0	115.3	123.0	123.3	122.8	120.0	127.7
	....	118.2	115.6	125.1	....	....	....	....
	....	....	118.0	....	....	....	....	....
H. lar	....	....	....	115.4	....	127.2	124.1	128.5
	....	....	....	....	....	....	126.8	124.0
	....	....	....	....	....	....	119.8	*132.4**
H. cinereus	....	....	....	....	....	127.7	....	120.3
	....	....	....	....	....	124.5	123.4	131.2
	....	....	....	....	....	....	....	*129.0**
H. pileatus	....	125.2	113.1	117.0	120.5	119.1	118.5	122.6
	....	116.5	115.7	....	....	....	....	124.4
	....	....	....	....	....	....	....	127.3
H. agilis	....	....	....	....	126.1	123.7	117.5	*131.3**
H. leucogenys	....	....	....	123.6	....	131.8	122.5	138.8
	....	....	....	....	....	....	....	139.2
H. klossi	....	....	115.2	111.5	119.2	122.0	....	*126.5**
S. syndactylus	....	....	132.8	134.0	137.2	137.9	141.7	141.5
	....	....	....	....	....	145.7	149.1	146.3
	....	....	....	....	....	....	....	150.8
	....	....	....	....	....	....	....	*148.3**

The extreme position of the gibbons and siamangs among the catarrhines in regard to the intermembral index, and the specific and generic differences of this proportion within the family of Hylobatidae have already been discussed in the chapter on limb bones. It may be emphasized once more that of all adult primates the siamang possesses the longest arms in proportion to its legs. The orang-utan ranks second in this respect and the gibbon third. The difference between the siamang and the gibbons is already present in older fetuses and in infants (see Table 28). This generic difference is due not to longer arms in the former, but to relatively longer legs in the latter (see Tables 26 and 27).[9]

This difference in the proportion between upper and lower limb between the gibbons and the siamang is also very evident in the intermembral index constructed of the total lengths of the limbs, which include the most distal segments (length of the hand and height of the foot). According to this index, the total length of the upper limb amounts on an average to 158.8 per cent of the total length of the lower limb in the 16 adult gibbons, whereas to 177.5 per cent in the 8 adult siamangs. The ranges of individual variations of these two series do not overlap. This particular proportion averages in adults: 111 in lower catarrhines, 169 in orang-utans, 135 in chimpanzees, and 136 in gorillas (Schultz, 1931). These figures demonstrate again that the siamang is distinguished by possessing the highest intermembral index of all catarrhines.

That the forearm grows more intensively than the upper arm is shown conclusively by the figures in Table 29. In *H. concolor, e. g.*, the length of the radius amounts to only 76 per cent of the length of the humerus in an embryo, to 95 per cent in a fetus close to term, to 107 per cent in a young juvenile, but to 116 per cent in an adult. In the infantile *H. leucogenys* the radius is as yet no longer than the humerus, in the juveniles of the same species the radius has become 6 per cent longer than the humerus, and in the parents of the first two specimens the radius has even grown to 114 to 118 per cent of the length of the humerus. In the chapter on limb bones it has already been stated that

[9] In a former paper the author (1930) reached tentatively the opposite conclusion, but at that time it could be based merely upon a single juvenile siamang. In the meantime the author has been enabled to study 11 additional preserved siamangs (10 in Zürich and 1 in London) due to the kindness of Prof. O. Schlaginhaufen and of Dr. S. Zuckerman.

the Hylobatidae possess the proportionately longest forearms of all adult simian primates. In this connection it is particularly interesting to find that this extreme evolutionary specialization develops only by slow degrees during ontogeny.

The percentage participation of the hand in the total length of the upper limb changes with growth, as shown by the data collected in Table 30. In the embryo the length of the hand amounts to one-third of the total limb length. During early fetal life the hand grows more slowly than the upper arm and forearm, causing the index to decrease, but during late fetal development this relation is reversed and the index rises again to over 30 in all fetuses close to term. During postnatal

TABLE 29

The Length of the Forearm in Percentage of the Length of the Upper Arm. The Figures Marked With an Asterisk are the Averages Based Upon Measurements on Skeletons (From Table 16)

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	76.3	90.5	91.4	93.0	97.8	106.6	107.0	109.3	115.8
	....	....	90.0	93.9	102.0	....	....	....	....
	....	....	....	95.1	....	....	....	....	....
H. lar	....	....	....	....	97.3	....	101.3	110.3	113.3
	....	....	....	....	....	....	....	110.9	112.6
	....	....	....	....	....	....	....	108.8	*112.1**
H. cinereus	....	....	....	....	....	....	108.7	104.2	106.8
	....	....	....	....	....	....	106.0	....	109.2
	....	....	....	....	....	....	....	....	*111.7**
H. pileatus	....	....	87.0	97.4	100.5	102.5	102.2	107.0	108.3
	....	....	91.3	98.5	....	....	....	....	110.0
	....	....	....	....	....	....	....	....	113.8
H. agilis	....	....	....	....	....	100.7	105.3	110.3	*116.3**
H. leucogenys	....	....	....	....	100.0	....	105.8	105.9	114.2
	....	....	....	....	....	....	....	....	118.0
H. klossi	....	....	....	95.4	104.2	101.7	104.5	....	*116.5**
S. syndactylus	....	....	....	90.7	94.2	93.6	102.1	107.5	101.8
	....	....	....	....	....	....	104.7	105.8	106.5
	....	....	....	....	....	....	....	....	109.0
	....	....	....	....	....	....	....	....	*111.2**

growth there occurs a second decrease in this proportion, which averages 23.5 in the 16 adult gibbons and 22.1 in the 8 adult siamangs. These growth changes correspond very closely to those existing in man (see Schultz, 1926, Fig. 4). These relative hand lengths of adult Hylobatidae are shorter than those of adults of the other higher primates, in which they amount to 28.4 in an orang-utan, 29.5 in a chimpanzee, 25.8 in a gorilla and 25.4 in man (Schultz, 1927). It can be concluded, therefore, that the tremendous lengthening of the upper limb of the Hylobatidae has affected the hand much less than the upper arm and, particularly, the forearm. Nevertheless, the hands of gibbons and of siamangs are exceptionally long, as is shown by expressing the hand length in proportion to the trunk height. According to Mollison (1911) this percentage relation is highest among all primates in the orang-utan (63.4) and second highest in the siamang (58.1).

There is practically no difference between gibbons and siamangs in the relative length of the hand, but in regard to the proportionate

TABLE 30

The Length of the Hand in Percentage of the Total Length of the Upper Limb

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	33.0	26.6	28.9	29.2	27.7	27.9	27.2	25.4	23.7
	....	....	29.3	30.1	24.7	....	....	....	....
	....	....	....	30.8	....	....	....	....	....
H. lar	....	....	....	....	30.4	....	26.0	25.5	25.1
	....	....	....	....	....	....	....	25.2	26.4
	....	....	....	....	....	....	....	26.3	....
H. cinereus	....	....	....	....	....	....	24.5	....	23.6
	....	....	....	....	....	....	24.4	24.0	20.7
H. pileatus	....	....	26.6	30.6	27.7	26.6	26.3	24.9	22.6
	....	....	25.8	30.7	....	....	....	....	23.5
	....	....	....	....	....	....	....	....	24.2
H. agilis	....	....	....	....	....	25.5	24.9	24.3	....
H. leucogenys	....	....	....	....	31.5	....	25.7	27.3	23.1
	....	....	....	....	....	....	....	....	21.2
H. klossi	....	....	....	30.6	25.2	24.8	24.5	....	....
S. syndactylus	....	....	....	....	30.9	25.7	25.3	24.6	21.0
	....	....	....	....	....	....	23.8	21.5	22.1
	....	....	....	....	....	....	....	....	23.6

breadth of the hand there does exist a significant difference. In the 16 adult embalmed gibbons, measured by the author, the hand breadth amounts on an average to 23.8 per cent of the hand length, whereas in the 8 adult siamangs to 28.5 per cent. The values for only two of the gibbons (*H. leucogenys* = 26.9 and *H. cinereus* = 30.3) are higher than the minimum value (26.6) among the siamangs. The extremely slender hand of the gibbons and the comparatively broader palm and fingers of the siamang are illustrated by the photographs in plate 2. In all anthropoid apes and in man the hand is proportionately broader than even in the siamang. The relative hand breadth averages among adults 32.4 in orang-utan, 34.8 in chimpanzee, 41.6 in man, and 58.6 in gorilla (Schultz, 1931).

As shown by plate 2, the thumb of the Hylobatidae branches from the palm very close to the wrist, so that the longest part of the first meta-

TABLE 31

The Length of the Thumb (From Styloid Process of Radius) in Percentage of the Length of the Hand

SPECIES	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	59.3	57.9	57.7	54.8	52.7	53.2	54.1	52.7
	....	57.3	55.8	55.2	....	....	....	....
	....	....	55.2	....	....	....	....	....
H. lar	....	....	....	54.1	....	54.9	51.5	53.7
	....	....	....	....	....	....	55.9	55.2
	....	....	....	....	....	....	55.1	....
H. cinereus	....	....	....	....	....	60.0	....	56.1
	....	....	....	....	....	61.2	62.3	54.4
H. pileatus	....	62.5	55.9	56.5	54.1	54.0	52.5	52.1
	....	66.7	55.6	....	....	....	....	54.9
	....	....	....	....	....	....	....	57.6
H. agilis	....	....	....	....	52.7	48.3	48.4	....
H. leucogenys	....	....	....	55.7	....	53.3	53.4	51.0
	....	....	....	....	....	....	....	56.4
H. klossi	....	....	59.2	62.3	62.1	60.1	....	....
S. syndactylus	....	....	....	55.0	54.8	52.4	54.5	49.2
	....	....	....	....	....	53.0	55.2	54.5
	....	....	....	....	....	....	....	57.0

carpal bone belongs to the "free portion" of the thumb. These conditions are unique among all catarrhine (and platyrrhine) primates, but are not yet present in embryos and young fetuses of the gibbons and siamangs.

The length of the thumb (measured from the styloid process of the radius) in percentage of the total hand length decreases more or less in the course of growth in most primates (see Schultz, 1924 and 1926). In the Hylobatidae this general ontogenetic reduction of the relative thumb length is also recognizable from the figures in Table 31. This proportion averages 54.6 in adult gibbons and the same (54.5) in adult siamangs. According to these values the Hylobatidae possess a relatively much shorter thumb than man (average for adult whites = 69.2), but a considerably longer one than the orang-utan (average for 5 adults = 43.7) or the chimpanzee (average for 6 adults = 47.4).

TABLE 32

The Length of the Great Toe (Measured From Heel to Tip of Toe) in Percentage of the Total Foot Length

SPECIES	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	88.7	87.2	86.9	87.3	84.1	85.1	85.8	85.3
	....	86.8	86.3	86.7	....	....	....	....
	....	....	86.6	....	....	....	....	....
H. lar	....	....	....	85.9	....	83.8	85.9	83.7
	....	....	....	....	....	....	85.2	85.7
	....	....	....	....	....	....	83.1	....
H. cinereus	....	....	....	....	....	85.7	....	83.6
	....	....	....	....	....	86.5	86.2	83.0
H. pileatus	....	88.5	86.9	86.8	83.5	84.7	84.3	80.4
	....	86.9	85.7	....	....	....	....	82.9
	....	....	....	....	....	....	....	84.3
H. agilis	....	....	....	....	84.4	86.7	84.3	....
H. leucogenys	....	....	....	85.6	....	83.4	84.6	84.5
	....	....	....	....	....	....	....	84.4
H. klossi	....	....	87.2	91.2	90.5	89.4	....	....
S. syndactylus	....	....	....	85.3	82.8	85.3	84.3	80.5
	....	....	....	....	....	82.7	83.0	82.8
	....	....	....	....	....	....	....	85.7

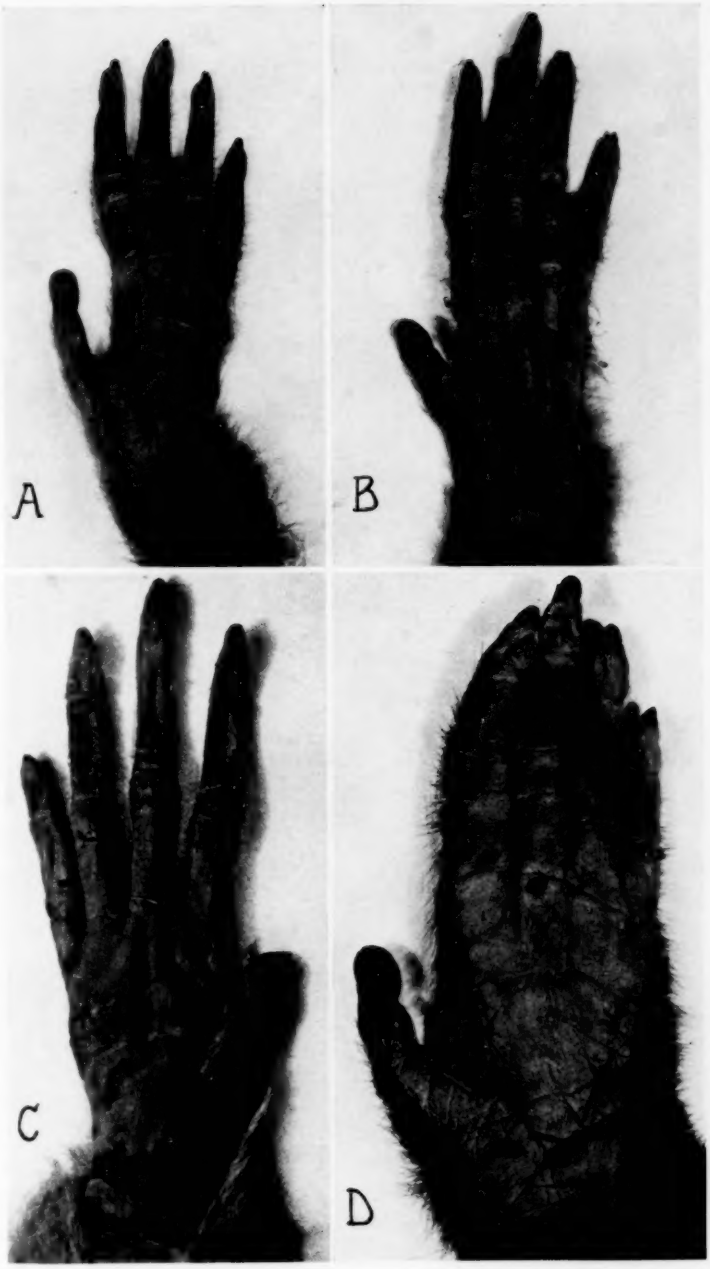

PLATE 2. HANDS OF A = HYLOBATES CINEREUS (J. H. No. 182), B = HYLOBATES AGILIS (J. H. No. 36), C = HYLOBATES PILEATUS (J. H. No. 132), D = SYMPHALANGUS SYNDACTYLUS (N. M. No. 255980)

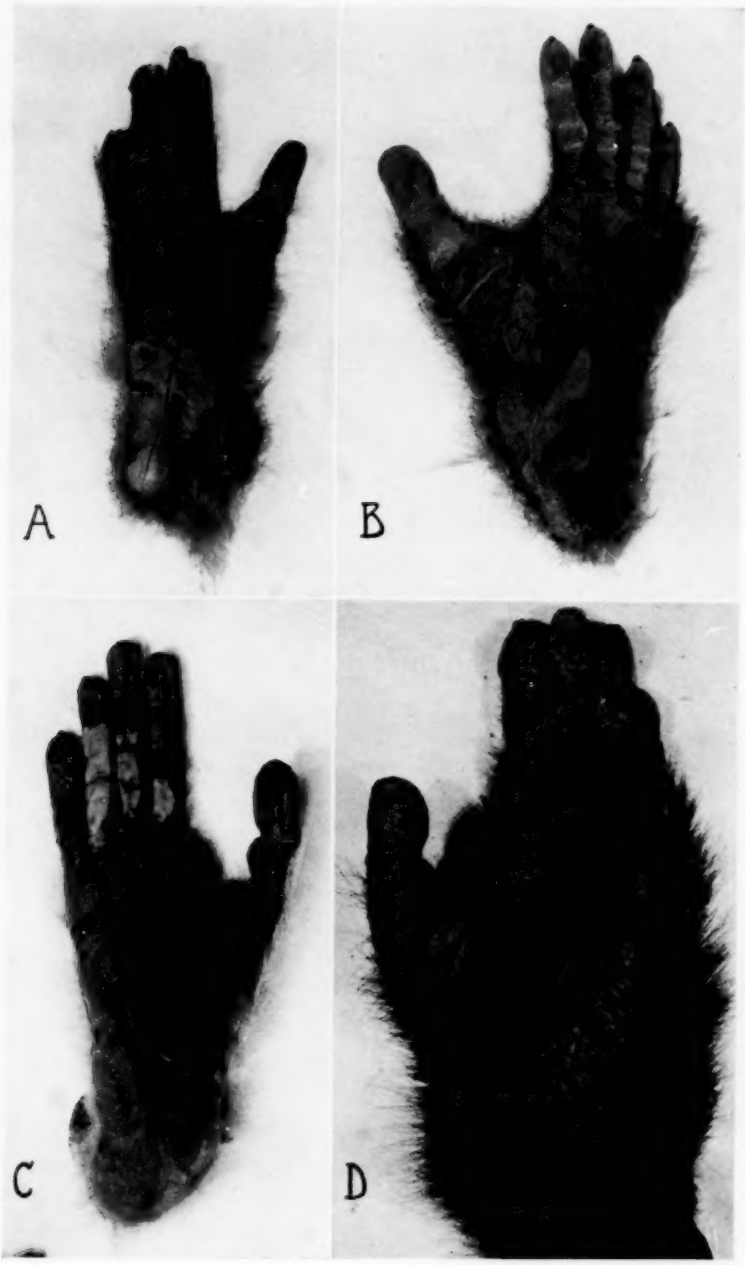

PLATE 3. FEET OF A = HYLOBATES AGILIS (J. H. No. 36), B = HYLOBATES CINEREUS (J. H. No. 189), C = HYLOBATES PILEATUS (J. H. No. 132), D = SYMPHALANGUS SYNDACTYLUS (N. M. No. 255980)

The first digit of the foot, like that of the hand, shows in the Hylobatidae an unusually long "free portion"; *i. e.*, the cleft between the first two digits reaches far proximally into the metatarsal region (see plate 3). That the great toe does not grow as intensively as the total foot length is shown by the figures in Table 32, which express the distance from the heel to the tip of the great toe in percentage of the distance from the heel to the tip of the middle toe. This proportion decreases in general with advancing age in most monkeys and apes, but increases in man, who possesses in adult life the greatest relative length of the hallux among all primates (Schultz, 1926). In the 16 adult gibbons this relative great toe length averages 83.5 and in the 8 adult siamangs practically the same, namely 82.8. *Hylobates* (*Brachitanytes*) *klossi* has at all available growth stages somewhat higher indices than the gibbons and siamangs of corresponding ages. Since the same relation exists in regard to the proportionate length of the thumb (Table 31), it can be stated that the subgenus *Brachitanytes* possesses relatively longer first digits on the foot as well as on the hand than the other Hylobatidae, and that the former changes less (if at all) in this respect from the condition typical of all fetuses than do the latter. In 5 adult orang-utans, measured by the author, the relative great toe length averages 55.1, whereas in 6 adult chimpanzees 85.8. In the Hylobatidae, therefore, the great toe reaches proportionately much farther forward than in orang-utans, but not quite as far as in chimpanzees. Comparative figures for other primates will be given in a later publication, in which the full significance of these data will be discussed.

c. Head

The relative size of the brain part of the head is expressed by the percentage relation between the average diameter of the head (head length + head breadth + head height : 3) and the height of the trunk. This index decreases very markedly with advancing growth in the Hylobatidae (see Table 33), as in other primates (see Schultz, 1926), showing that the head becomes proportionately much smaller with increase in general body size. At birth this relative size of the head amounts to 59.0 in man and to about the same in the Hylobatidae (average of the 6 fetuses close to term = 63.0 and of the 7 youngest infants = 55.3). In adults the index has decreased to roughly 31 in man, whereas, on an average, to 25.6 in gibbons and to 26.3 in siamangs. In adult orang-utans this proportion averages 28.2 and in adult chimpanzees 26.6, whereas in

adult catarrhine monkeys only 21.3 (Schultz, 1931). This relative head size corresponds only roughly to the relative size of the brain cavity, as discussed in chapter 3, *A. a*; the former is influenced not only by the size of the brain, but also by the thickness of the skull, the temporal muscles, and the scalp. These factors account for the apparent discrepancy between the findings that the siamangs possess relatively larger heads but proportionately smaller brains than the gibbons.

The face grows more rapidly and more intensively than the brain part of the head. This is shown conclusively by the figures in Table 34, which express the total height of the face (*nasion - gnathion*) in percentage of the average diameter of the head. This index increases a great deal, particularly during growth after birth, when the face gains rapidly in height under the influence of the developing dentition. During fetal life the face height amounts to only 43 to 51 per cent of the average head diameter, but in adults this percentage has increased to

TABLE 33

The Average Diameter of the Head (Head Length + Head Breadth + Head Height : 3) in Percentage of the Trunk Height

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	126.7	63.3	67.6	64.3	61.2	48.0	39.1	31.3	24.7
	....	....	62.4	64.8	48.7	....	....	....	....
	....	....	....	60.8	....	....	....	....	....
H. lar	....	....	....	....	59.7	....	36.9	30.2	25.6
	....	....	....	....	....	....	....	29.0	26.3
	....	....	....	....	....	....	....	27.3	....
H. cinereus	....	....	....	....	....	....	34.6	....	25.1
	....	....	....	....	....	....	33.0	31.4	25.2
H. pileatus	....	....	73.2	58.5	52.6	....	....	....	....
	....	....	63.6	63.8	....	....	....	....	....
H. agilis	....	....	....	....	....	41.8	33.3	29.5	....
H. leucogenys	....	....	....	....	56.1	....	33.7	31.3	25.7
	....	....	....	....	....	....	....	....	26.4
H. klossi	....	....	....	65.7	54.5	49.3	45.9	....	....
S. syndactylus	....	....	....	....	54.5	46.3	30.8	29.4	24.6
	....	....	....	....	....	....	32.2	28.8	26.3
	....	....	....	....	....	....	....	....	28.4

78.0, as an average of the 13 gibbons, and to 87.6, as an average of the 8 siamangs. It is interesting to find that all the individual variations among the latter lie above the variations among the former; indeed, throughout postnatal growth the siamangs have proportionately higher faces than the gibbons of corresponding ages. *Hylobates* (*Brachitanytes*) *klossi* belongs in this respect clearly in the genus *Hylobates*. The data in Table 6 have shown that the siamang possesses a relatively longer and more projecting palate than the gibbon. Based upon the additional information from Table 34, it can be stated that the face is not only longer but also much higher in *Symphalangus* than in any of the species of *Hylobates*.

In most lower catarrhines the relative height of the face is greater than in the Hylobatidae and this chiefly on account of their comparatively small average head diameter. For instance, the following values

TABLE 34

The Total Height of the Face in Percentage of the Average Diameter of the Head (Head Length + Head Breadth + Head Height : 3)

SPECIES	EMBRYO	FETUS I	FETUS II	FETUS III	INFANT I	INFANT II	JUVEN. I	JUVEN. II	ADULT
H. concolor	42.8	45.2	48.6	47.8	53.8	63.3	64.8	71.3	79.3
	....	....	48.5	48.0	56.7	....	....	....	....
	....	....	....	51.0	....	....	....	....	....
H. lar	....	....	....	....	54.6	....	66.9	73.9	78.4
	....	....	....	....	....	....	....	73.9	83.6
	....	....	....	....	....	....	....	72.1	....
H. cinereus	....	....	....	....	....	....	68.2	....	83.7
	....	....	....	....	....	....	74.2	72.9	80.8
H. pileatus	....	....	50.6	50.9	52.9	....	68.4	69.3	72.5
	....	....	50.3	50.7	....	....	....	....	75.2
	....	....	....	....	....	....	....	....	79.0
H. agilis	....	....	....	....	....	62.8	69.0	70.6	....
H. leucogenys	....	....	....	....	54.4	....	70.6	69.7	79.7
	....	....	....	....	....	....	....	....	77.3
H. klossi	....	....	....	48.2	52.9	57.7	66.7	....	....
S. syndactylus	....	....	....	....	63.1	69.0	83.8	82.9	83.8
	....	....	....	....	....	....	82.2	84.5	87.6
	....	....	....	....	....	....	....	....	94.4

are obtained for adult males: *Pithecus rhesus* = 95.0; *Lasiopyga pygerythra* = 91.4; *Pygathrix germaini* = 90.7 (species names according to Elliot, 1913). In anthropoid apes this index is also higher than in gibbons and even than in siamangs, but, in contrast to most lower catarrhines, chiefly on account of the great size of the face itself. In adult orang-utans, for instance, the index amounts to 103.0 in a female, to 118.2 in one male, and even to 121.5 in another and very large male. Incidentally, such a secondary sex difference, according to which males possess a relatively much larger face than females (in consequence of the larger dentition), exists in all anthropoids but could not be found in the Hylobatidae.

A great many other body proportions have been studied by the author in the Hylobatidae. The above examples must suffice at present to demonstrate that the different parts of the body grow often at differing rates and that, in consequence, the proportions can change very markedly with advancing age. It can be concluded that in general the various specializations in body proportions, characteristic of adult Hylobatidae, develop only gradually in the course of individual growth. According to most of the proportions of the adults, the gibbons and even more so the siamang, stand closer to the anthropoid apes than to the lower catarrhines. The full significance of these and other, additional conclusions will be apparent only when the corresponding growth changes in all other primates have been completely worked out.

d. Individual variations

Comparisons between the indices of different individuals of the same species and age in the Tables 23 to 34 reveal the fact that in regard to some proportions there exists but little tendency to vary, whereas in regard to others, individuals may differ from one another to a surprising degree. For instance, in the two adult *H. leucogenys* the relation between the lengths of the limbs and the height of the trunk differs strikingly, the relative leg length being 134 and 153 respectively, and the relative arm length 229 and 259 respectively, yet the relation in length between the upper and the lower limb is practically the same in both individuals, *i. e.*, 138.8 and 139.2 respectively. Very similar conditions occur among the adult siamangs. Thus, in specimen No. 68 the relative leg length amounts to 122, whereas in specimen No. 61 to 139. The relative arm length of the former is 221 and that of the latter 255. In spite of these wide individual differences in the relation between limb

length and trunk height, the proportion between the lengths of the limbs is again found to be nearly identical in both specimens, namely 149 in No. 68 and 151 in No. 61.

The two adult male *H. cinereus* (specimens No. 23 and 24) were shot in their native jungle of Java. They are strikingly similar in regard to many of their body proportions (see Tables 23 to 34), yet in regard to certain others they differ very markedly from each other. For instance, the shoulder breadth in percentage of the trunk height amounts to 54.4 in No. 23, whereas to 59.2 in No. 24; the distance between the nipples in percentage of the breadth of the chest is 20.9 in the former and 30.7 in the latter; the hand breadth in percentage of the hand length is only 20.8 in No. 23, whereas 30.3 in No. 24; the breadth of the head in percentage of the length of the head amounts to 86.2 in the former and to 94.4 in the latter. Such individual variations are by no means confined to adults, but are often fully as pronounced among fetuses. Some of these variations are most likely comparable to the so-called constitutional differences in man (relative chest circumference, limb length, hand breadth, etc.) and may, in their probable connection with physiological variations, play an important rôle for selective processes. Throughout this paper the data presented show that the Hylobatidae are unquestionably provided with an abundance of variations for possible selections. This tendency to vary exists not only in such features as the number of vertebrae or of teeth, the color and density of hair, the dimensions and proportions of the outer body and of the various parts of the skeleton, but also in regard to such details as the exact extent of interdigital webbing or the degree of prominence of the nose. An extreme variation of the last-named feature is shown in plate 1, *B*, which illustrates an unusually prominent nose in a young *H. cinereus*. It is this marked and extensive variability which causes any valid taxonomic work on the Hylobatidae to be difficult, because it calls not only for large series of individuals but also for a consideration of as many different characters as possible. Most of the species are distinguishable only by a definite combination of many different variations.

CHAPTER 6. SUMMARY

Most of the results of this study on the Hylobatidae are summarized in Tables 35, 36, and 37. These results appertain to a wide variety of different bodily characters, yet some of the general conclusions can be only more or less tentative, awaiting further corroboration from the in-

TABLE 35

Summary of the Average Conditions of the Skull and the Teeth, as Discussed in this Paper, in the Subgenera Hylobates and Brachitanytes, in the Genus Symphalangus and, for a General Comparison, in Catarrhine Monkeys and in One of the Large Apes

	CHARACTER	LOWER CATARRHINES	GENUS HYLOBATES		GENUS SYMPHALANGUS	ORANG-UTAN
			Hylobates	*Brachitanytes*		
SKULL:	Cranial capacity (cu. cm.)	57-163 (Oppenheim, 1912)	97.5	87.1	124.6	358 ♀, 395 ♂ (Oppenheim, 1912)
	Skull length (mm.)	.....	79.3-83.5	75.6	90.8	.....
	Glabellar thickness (mm.)	.....	2.7-3.8	1.6	8.0	.....
	Biorbital breadth (mm.)	.....	61.9-65.0	58.3	70.3	.....
	Palate length (mm.)	.....	38.3-41.0	36.8	52.9	.....
	Skull height in % of skull length	.....	63.7-67.6	69.1	60.6	.....
	braincase relatively	.....	high	very high	low	.....
	Postorbital breadth in % of biorbital br.	.....	74.0-76.7	76.6	67.1	ca. 65 in ♂
	Postorbital constriction comparatively	little pronounced	marked	marked	very marked	very marked
	Palate length in % of skull length	.....	48.8-53.5	49.7	63.9	.....
	Palate breadth in % of skull breadth	.....	52.1-54.5	52.8	62.8	.....
	Palate in proportion to brain case	small to large	small	very small	large	large
	Squamous portion of temporal bone	relatively small	relatively small	relatively small	relatively large	relatively large
	Sagittal crest	absent except in a few ♂	absent	absent	present in some ♂	present in all ♂
	Cranio-pharyngeal canal present in % cases	2 to 21	35	90	64	24
	Angle between mandibular symphysis and alveolary horizon	small	small	medium	large	medium
TEETH:	Supernumerary molars	generally rare	extremely rare (0.7%)	unknown	common (13%)	very common (20%)
	Congenital absence of third molars	very rare	not rare	unknown	not found	unknown
	Eruption of teeth occurs	early	early	?	?	late

Congenital absence of third molars	very rare	not rare	unknown	not found	unknown
Eruption of teeth occurs	early	early	?	?	late

TABLE 36

Summary of the Average Conditions of the Skeleton (Except the Skull), as Discussed in This Paper, in the Subgenera Hylobates and Brachitanytes, in the Genus Symphalangus and, for a General Comparison, in Catarrhine Monkeys and in One of the Large Apes

CHARACTER	LOWER CATARRHINES	GENUS HYLOBATES		GENUS SYMPHALANGUS	ORANG-UTAN
		Hylobates	*Brachitanytes*		
SPINE: Average number of lumbar vertebrae	7—6	5.0	5.2	4.6	4.0
Average number of thoracolumbar vertebrae	20—18	17.9	18.2	17.4	16.0
Average number of sacral vertebrae	3	4.4	4.8	4.5	5.1
Average number of coccygeal vertebrae	28—8	2.7	4.6	2.8	2.8
Average total number of vertebrae	ca. 48	31.9	34.6	31.6	30.8
STERNUM: Relative size and shape	very long and slender	short and broad	short and broad	very short and very broad	short and very broad
Manubrium length in % of corpus length ..	ca. 36	52.2	60.1	77.5	56.2
Corpus breadth in % of corpus length	ca. 14	36.7	44.1	61.0	57.5
PELVIS: Ilium length in % of ischium length	ca. 206	231.1	222.4	251.1	190
Pubis length in % of ischium length	ca. 87	94.6	94.7	112.3	100
Ilium breadth in % of ilium length	ca. 43	50.9	59.7	61.2	77
Ilium breadth in % of ischium length	ca. 88	117.8	126.3	153.6	147
Ilium comparatively	narrow	broad	broader	broadest	very broad
LIMB BONES:					
Radius length in % of humerus length	ca. 100	112.4	116.5	111.1	101
Tibia length in % of femur length	ca. 91	88.2	89.7	86.1	92
Humerus + radius in % of femur + tibia	ca. 89	128.5	126.5	148.3	144
Upper limb in proportion of lower limb	short	long	long	extremely long	very long

TABLE 37

Summary of the Average Conditions of the Outer Body, as Discussed in This Paper, in the Subgenera Hylobates and Brachitanytes, in the Genus Symphalangus and, for a General Comparison, in Catarrhine Monkeys and in One of the Large Apes

CHARACTER		LOWER CATARRHINES	GENUS HYLOBATES		GENUS SYMPHALANGUS	ORANG-UTAN
			Hylobates	*Brachitanytes*		
THROAT POUCH:	Throat pouch	absent	mostly absent	absent	present	present
	Hair in region of throat	very dense	dense	scanty	very scanty	extremely scanty
HAIRS per sq. cm. of skin:	Scalp	910	2,045	663	718	158
	Back	866	1,664	462	429	176
	Chest	172	545	277	251	107
ISCHIAL CALLOSITIES appear		long before birth; earlier than lanugo	immediately after birth (much later than lanugo)	considerable time after birth	late in infantile growth	only in occasional specimens (long after birth)
WEBBING BETWEEN TOES II AND III: At least proximal half of digits webbed		fairly common	occasionally	frequently	very frequently (but not always)	never
DIGIT II equally long or longer than digit IV: percentage of cases		0	71	75	79 to 93	0
BODY PROPORTIONS of adults:						
Chest circumference in % of trunk height		107	148.8	?	173.6	181
Chest breadth in % of chest depth....		87	118.2	?	124.8	127
Total lower limb length in % of trunk h.		107	146.5	?	131.4	118
Total upper limb length in % of trunk h.		119	237.8	?	233.4	200
Tot. upper limb l. in % of tot. lower limb l.		111	158.8	?	177.5	169
Hand breadth in % of hand length		33	23.8	?	28.5	32
Aver. head diameter in % of trunk height..		21	25.6	?	26.3	28
Face height in % of aver. head diameter ...		roughly 93	78.0	less than 80	87.6	114
Ear height in % of head length		45	40.0	?	31.4	25

vestigation of still other features. This admission is readily understood when it is remembered that no conclusions in regard to the exact relationships between various groups of primates can be accepted as absolutely final until they have taken into consideration all bodily parts and the physiological as well as the morphological conditions.

N. Position of the Family Hylobatidae within the Series Catarrhinae

a. Similarities to Lasiopygidae

Among the features discussed in this paper there are comparatively few in regard to which the Hylobatidae resemble more closely the catarrhine monkeys than they do the large apes. The gibbons have certainly no share in the trend toward a striking increase in body size, characteristic of the other higher primates. This trend is at best indicated in the siamang. *Hylobates* (*Brachitanytes*) *klossi* has most likely degenerated to a slight extent in its body size after its isolation on the relatively small Mentawi Islands. Such dwarfing is quite common among insular types.

The presence of ischial callosities in all Hylobatidae is frequently quoted as demonstration of their close relationship to the lower catarrhines and their being removed from the anthropoid apes. It has been shown, however, that there exists no sharp separation between catarrhines with callosities and those without. The fact that these structures appear ontogenetically so much later in gibbons, and still later in siamangs, than in the Old World monkeys, and that they are still encountered in occasional specimens of orang-utans and chimpanzees, favors the assumption of a gradual disappearance, rather than a sudden loss, of callosities among higher primates.

The early age of eruption of teeth, which has been noted in the gibbon, and the comparatively rapid rate of (most probably) general development represents unquestionably a primitive condition which the Hylobatidae have in common with the Lasiopygidae.

As another marked difference between gibbons and the large apes may be mentioned the great density of hair, characteristic of the subgenus *Hylobates*. This distinction, however, is of but little phylogenetic significance, since it separates also the true gibbons and the very closely related subgenus *Brachitanytes* as well as the related genus *Symphalangus*.

It is difficult to decide whether or not webbing between the second and third toes is a primitive character. At any rate the typical webbing

of the siamang neither speaks for a close relationship with lower catarrhines nor can it be regarded as a unique specialization. Such webbing is also very frequent in *H.* (*B.*) *klossi* and occurs in an occasional true gibbon; it does exist quite regularly in a few genera of the lower catarrhines (*e. g. Cercocebus*), but has also been found well developed in some chimpanzees, in many gorillas and in a considerable number of human beings.

b. Similarities to Pongidae

As shown by Tables 35 to 37, the Hylobatidae possess a great many characters which link them very closely with the large apes and separate them clearly from the catarrhine monkeys. Of these characters may be specially mentioned: (1) the far-reaching reduction in the total number of vertebrae, affecting the presacral as well as the caudal portion of the spine, and the very significant increase in the number of vertebrae participating in the formation of the sacrum; (2) the extreme degree of shortening and broadening of the sternum; (3) the widening of the pelvis, particularly the ilium; (4) the shortness and stoutness of the entire trunk; (5) the broadness of the chest; (6) the tremendous increase in the relative length of the limbs (compared to the trunk); (7) the great preponderance of arm length over leg length; (8) the proportionately large size of the brain part of the head; and (9) the wide range and very frequent occurrence of numerical variations in vertebrae. Much could be added to this enumeration, but the above examples are ample support of the statement that the Hylobatidae are much more closely related to the large apes than to the catarrhine monkeys. The same conclusion has been reached by the great majority of the investigators of this problem (*e. g.,* Gregory, 1916 and Weber, 1928) and is based upon the results of a variety of widely different studies. Quite recently it has been confirmed again by the researches on placentation of Wislocki (1929) and by those on the facial musculature of Huber (1931).

c. Specializations of Hylobatidae

Among the various features of the Hylobatidae there are, of course, many which are common property of all Old World primates and, therefore, are of no help in an attempt to determine the position of this family within the catarrhine series. On the other hand, among the characters of the Hylobatidae one finds some which are restricted to this

group and represent specializations which must have been acquired after the phylogenetic separation of the Hylobatidae. Of such peculiarities may be specially mentioned: (1) the lengthening of the limbs to a degree surpassing that of even the orang-utan; (2) the extreme lengthening of the radius in proportion to the humerus; (3) the lengthening of the second digits until they are as long as or longer than the fourth digits; (4) the unique length of the "free portion" of the thumb and of the great toe, connected with the extreme shifting in a proximal direction of the place at which these digits branch from palm or sole; (5) the exceptional lengthening of the ilium in proportion to the ischium, most pronounced in the siamang; (6) the very extreme shortening and broadening of the *corpus sterni* in the siamang; (7) the reduction in the average number of coccygeal vertebrae which has reached a greater extreme in the subgenus *Hylobates* than in any other primates; (8) the nearly perpendicular direction of the mandibular symphysis in the siamang; (9) the various symptoms of degeneracy of the third molars in gibbons; and (10) the great lengthening of the canines in the female as well as in the male.

Many, if not all, of these phylogenetic specializations of the gibbons and siamangs appear only gradually in the course of individual development. That the resemblance between the Hylobatidae and the other catarrhines, particularly the large apes, is much greater early than late in ontogeny has been demonstrated by the author (1926 and 1927) in previous publications. The present detailed data concerning the growth changes in the Hylobatidae fully sustain the above conclusion of earlier studies. Most of the age changes in the body proportions of gibbons and siamangs are in principle the same as the corresponding changes in catarrhine monkeys and in the large apes, but in degree these changes differ often to a considerable extent. For instance, the forearm grows more rapidly than the upper arm in all the primates investigated so far, but in no other primate does the amount of increase in the forearm surpass that in the upper arm as much as in the gibbons.

O. Subdivision of the Family Hylobatidae

No systematic attempt has been made in this study to separate and define the species of the Hylobatidae. It may be stated, however, that, on the strength of the data presented in this paper, the author feels confident that there exist at least the nine species named in the fourth column of Table 1. Even though some of these species may not always

be distinguishable by the color of hair or by easily visible cranial characters, the lack of such differences may be more than replaced by the presence of constant and significant differences in the exact body proportions and skeletal indices, or in the degree of density of hair, or, finally, in a definite combination of certain variations.

The number, comparative size and significance of the differences between the species are very much greater in some instances than in others. In order to do full justice to this important finding it is absolutely necessary to recognize not only specific but also subgeneric and even generic differences within the family of Hylobatidae.

a. Generic differences within the family

Tables 35 to 37 contain a large number of characters which differ in the two genera of the Hylobatidae to a much greater extent than the same characters differ among the species of the genus *Hylobates.* The more important distinctive characters are briefly enumerated in the following. The genus *Symphalangus* differs from the genus *Hylobates* in possessing: (1) the larger body weight and the larger dimensions of nearly all bodily parts; (2) the much stouter trunk and relatively broader chest; (3) the shorter legs (in proportion to the trunk) and the much longer arms (in proportion to the legs); (4) the relatively broader hands; (5) the proportionately much higher face; (6) the smaller ears; (7) the presence of a large throat pouch; (8) the higher frequency of extensive webbing between toes II and III; (9) the later appearance of ischial callosities (than in subgenus *Hylobates*); (10) not nearly as great a density of hair (as in subgenus *Hylobates*); and in regard to the skeleton (11) the proportionately longer and broader palate; (12) the proportionately lower brain case; (13) the more pronounced postorbital constriction; (14) the orbits projecting farther in a vertical and in a lateral direction; (15) the greater glabellar thickness of the skull wall; (16) the relatively larger temporal squama; (17) the occasional presence of a sagittal crest and the generally more marked approximation of the temporal lines; (18) the steeper profile of the mandibular symphysis; (19) the frequent occurrence of supernumerary molars and the lack of signs of suppression of the third molars; (20) the smaller average number of lumbar and of thoraco-lumbar vertebrae, partly in consequence of the disappearance of individual variations of still 19 thoracolumbar vertebrae and the appearance of variations of only 16 of these vertebrae; (21) an extremely short and broad *corpus sterni;* (22)

the proportionately much longer and broader ilium; and (23) the proportionately longer pubic bone and generally wider pelvis.

The great majority of these distinguishing characters of the siamang do not differ in principle from the corresponding features of the gibbons, but are merely specializations, common to all Hylobatidae, which have carried the siamang farther than the gibbon away from the original ancestral condition. In a phylogenetic "family tree" this would have to be represented by two generic branches diverging very little but reaching in the siamang beyond the level attained by the gibbons. Both branches would have to be directed more or less parallel to the branch showing the evolutionary trend of the orang-utan. The latter branch would be approached a good deal more closely by the siamang than by any of the gibbons. There is no denying the fact that many similar evolutionary tendencies have been at work in the Hylobatidae as in the large apes and especially in the Asiatic form, the orang-utan. To mention but a few random examples of these trends: reduction in the number of vertebrae, broadening of the chest and of the pelvis, lengthening of the limbs, shortening of the sternum, migration of the shoulder blades toward the back, enlargement of the acromial processes beginning in the siamang, and folding of the edge of the ears. Many of these tendencies manifest their effect primarily in modifications of the processes of growth. This will all be discussed in detail in later publications on the growth, body proportions, etc. of the large apes.

b. Subgeneric differences within the genus Hylobates

Hylobates (*Brachitanytes*) *klossi* differs more from any other species within the genus *Hylobates* than any two species of the subgenus *Hylobates* differ from one another. Yet the former shows also so many striking similarities to the latter that all can safely be included in one and the same genus, and this in spite of the fact that in regard to a few characters the subgenus *Brachitanytes* resembles more closely the genus *Symphalangus* than the subgenus *Hylobates* (degree of density of hair and frequency of webbing between the toes). In some respects *Hylobates* (*Brachitanytes*) *klossi* is more primitive than any of the other Hylobatidae (*e. g.*, the average total number of vertebrae), whereas in certain other respects it represents an intermediate step between the degrees of specialization reached by the gibbons proper and by the siamangs (*e. g.*, relative breadth of the ilium).

The subgenus *Brachitanytes* differs from the subgenus *Hylobates* in possessing (see also Tables 35 to 37): (1) not nearly as dense a coat of hair; (2) comparatively few hairs in the region of the throat; (3) the higher frequency of extensive webbing between the second and third toes; (4) comparatively long thumbs and great toes; and in the skeleton (5) the proportionately longer radius and tibia; (6) the proportionately shorter and broader ilium; (7) the proportionately shorter and broader *corpus sterni;* (8) the higher average numbers of vertebrae in all (except cervical) spinal regions; (9) the smaller average cranial capacity and cranial dimensions; (10) the relatively higher skull; (11) the nearly constant persistence of a cranio-pharyngeal canal; and (12) the steeper inclination of the profile of the mandibular symphysis. In regard to its small relative size of the palate and its insignificant degree of postorbital constriction the subgenus *Brachitanytes* does not actually fall outside the range of species differences within the subgenus *Hylobates,* but it equals the minimum variation among the latter.

It is hoped that it will become possible some day to supplement this chapter by a consideration of the exact conditions in preserved bodies of adult *Hylobates* (*Brachitanytes*) *klossi,* material which is not available at present in any collection.

After this paper was written there appeared an article by Miller (1933) on the classification of the gibbons. Miller distinguishes four groups among the Hylobatidae and concludes: ". . . in view of the small number of species concerned, I think that the most convenient course is to unite all four groups in the genus *Hylobates,* and to distinguish them from each other subgenerically as follows:" *Nomascus* subgen. nov. (*concolor*-type), *Hylobates* (*lar*-type), *Brachitanytes,* and *Symphalangus.* It will be noted that the first two subgenera of Miller compose what the writer has considered the one subgenus *Hylobates.* Miller bases his division of the latter subgenus chiefly upon the formation of the scrotum and the occurrence of a small gular sac in the male.

It is evident from the results of the present study that the writer cannot agree with the view that *Symphalangus* represents merely a subgenus. It should be recognized taxonomically that the differences between the siamang and the gibbons are more numerous as well as more significant than any differences existing between various types of gibbons.

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TABLES OF BASIC DATA (I to VII)

TABLE I

Capacity and Proportions of Skulls of Hylobates lar, H. agilis, and H. pileatus. The Specimens are Arranged According to Increasing Capacity in the Same Sex and Species

SPECIES	SEX	COLLECTION	CAPACITY (cu. cm.)	SKULL HEIGHT / SKULL LENGTH	POSTORBITAL BR. / BIORBITAL BREADTH	BIORBITAL BREADTH / SKULL BREADTH	PALATE LENGTH / SKULL L. — THICKN.	PALATE BREADTH / SKULL BREADTH
Hylobates lar	♀	A. S. 129	84	68.9	80.7	98.3	48.6	55.2
Hylobates lar	♀	A. M. 752 C. A.	85	61.0	73.0	101.5	54.5	53.2
Hylobates lar	♀	N. M. 83262	90	71.6	78.7	100.0	53.4	49.2
Hylobates lar	♀	N. M. 83264	94	67.1	75.8	101.6	52.6	55.7
Hylobates lar	♀	A. M. 54668	104	65.9	74.6	101.5	54.0	53.2
Hylobates lar	♀	N. M. 83265	108	74.4	82.3	98.4	52.0	50.8
Hylobates lar	♀	A. M. 54659	118	64.7	80.7	94.0	50.0	50.0
Hylobates lar	♂	A. S. 911	85	68.4	77.1	101.7	49.3	50.0
Hylobates lar	♂	N. M. 143564	90	67.9	73.9	112.1	53.2	55.2
Hylobates lar	♂	A. M. 54669	92	66.7	73.5	104.8	55.4	52.5
Hylobates lar	♂	A. S. 907	92	65.8	78.7	98.4	50.6	53.2
Hylobates lar	♂	N. M. 143566	94	69.6	73.8	100.0	50.7	47.5
Hylobates lar	♂	N. M. 111970	97	67.1	74.6	103.3	54.7	55.7
Hylobates lar	♂	N. M. 111989	98	64.2	76.6	103.2	54.5	53.2
Hylobates lar	♂	N. M. 171982	102	72.5	78.5	101.6	55.3	53.1
Hylobates lar	♂	A. M. 54660	102	65.1	72.1	106.2	58.7	51.6
Hylobates lar	♂	N. M. 111988	103	67.5	77.1	95.3	51.3	53.1
Hylobates lar	♂	N. M. 143567	104	67.1	75.0	101.6	47.5	47.6
Hylobates lar	♂	N. M. 143569	113	72.5	81.0	100.0	50.7	50.8
Hylobates lar	♂	A. M. 54663	114	64.7	73.5	106.2	51.8	51.6
Hylobates agilis ..	♀	N. M. 114501	86	58.8	75.0	103.4	50.7	53.4
Hylobates agilis ..	♀	N. M. 123154	88	63.8	73.0	108.6	52.0	60.3
Hylobates agilis ..	♀	N. M. 113176	91	63.8	74.6	98.3	46.1	51.7
Hylobates agilis ..	♀	A. M. 9244	92	68.4	73.5	106.6	53.2	53.3
Hylobates agilis ..	♀	N. M. 144092	103	66.7	72.3	103.2	50.0	54.0
Hylobates agilis ..	♂	N. M. 114499	87	60.5	66.2	119.3	50.0	59.6
Hylobates agilis ..	♂	N. M. 144091	94	68.0	76.7	100.0	52.7	56.7
Hylobates agilis ..	♂	N. M. 143573	94	63.4	71.9	104.9	51.3	49.2
Hylobates agilis ..	♂	N. M. 113180	95	62.2	75.4	96.8	49.4	49.2
Hylobates agilis ..	♂	N. M. 123153	98	64.6	77.8	191.6	50.6	58.1
Hylobates agilis ..	♂	N. M. 144089	104	64.0	72.7	108.2	53.7	57.4
Hylobates agilis ..	♂	N. M. 141158	107	68.3	77.6	103.1	51.9	52.3
Hylobates agilis ..	♂	N. M. 143574	111	64.7	75.0	100.0	50.6	53.1
Hylobates pileatus	♀	A. S. 780	81	63.8	75.8	108.7	48.0	56.1
Hylobates pileatus	♀	A. S. 782	88	63.8	77.0	96.8	50.0	50.8
Hylobates pileatus	♀	A. S. 781	91	66.3	75.4	103.4	48.0	54.2
Hylobates pileatus	♀	A. S. 783	91	64.2	75.0	101.7	45.6	54.2
Hylobates pileatus	♀	A. M. 31593	92	63.4	71.0	108.7	49.3	56.1
Hylobates pileatus	♀	N. M. 201556	93	65.0	70.5	103.4	50.6	55.9
Hylobates pileatus	♀	A. S. 912	104	61.2	75.0	103.2	48.1	54.8
Hylobates pileatus	♂	N. M. 201554	99	61.0	77.8	101.6	51.2	53.2
Hylobates pileatus	♂	N. M. 201555	104	64.2	77.8	100.0	48.1	50.8

TABLE II.

Capacity and Proportions of Skulls of Hylobates concolor, H. cinereus, H. hoolock, H. klossi, and Symphalangus syndactylus. The Specimens are Arranged According to Increasing Capacity in the Same Sex and Species. All Skulls in Tables I and II are from Fully Adult Specimens.

SPECIES	SEX	COLLECTION	CAPACITY (*cu. cm.*)	SKULL HEIGHT / SKULL LENGTH	POSTORBITAL BR. / BIORBITAL BREADTH	BIORBITAL BREADTH / SKULL BREADTH	PALATE LENGTH / SKULL L. — THICKN.	PALATE BREADTH / SKULL BREADTH
Hylobates concolor	♀	N. M. 198270	93	64.1	75.0	101.7	53.3	54.2
Hylobates concolor	♀	N. M. 196782	97	67.1	80.0	96.8	50.0	48.4
Hylobates concolor	♂	A. S. 796	85	66.3	73.0	98.4	55.2	53.1
Hylobates concolor	♂	N. M. 198841	91	67.5	76.2	103.3	54.8	52.5
Hylobates concolor	♂	N. M. 198272	105	67.5	75.4	103.2	55.8	57.1
Hylobates concolor	♂	N. M. 198273	136	70.2	80.3	95.6	50.0	49.3
Hylobates cinereus	♀	N. M. 156471	94	59.3	71.4	106.8	45.8	54.2
Hylobates cinereus	♀	N. M. 142177	100	65.9	78.3	98.4	50.0	50.8
Hylobates cinereus	♀	N. M. 142178	107	69.5	73.4	98.5	51.2	47.7
Hylobates cinereus	♀	A. M. 80068	115	60.2	74.6	100.0	56.1	57.1
Hylobates cinereus	♂	N. M. 142175	103	68.0	77.1	96.8	51.3	52.4
Hylobates cinereus	♂	N. M. 142173	104	63.5	75.0	106.7	51.2	55.0
Hylobates hoolock	♀	A. C.	95	62.5	72.7	108.1	50.0	52.5
Hylobates hoolock	♂	N. M. 113178	93	61.7	68.1	111.3	56.6	53.2
Hylobates hoolock	♂	N. M. 113179	100	70.1	85.0	93.7	54.0	51.6
Hylobates klossi ..	♀	N. M. 121680	78	70.4	84.6	92.9	48.6	51.8
Hylobates klossi ..	♀	N. M. 121679	78	68.0	73.7	105.5	50.7	55.6
Hylobates klossi ..	♀	N. M. 121687	80	67.6	73.7	100.0	49.3	54.4
Hylobates klossi ..	♀	N. M. 49657	83	68.0	76.3	101.7	47.9	51.7
Hylobates klossi ..	♀	N. M. 121688	89	72.0	77.6	101.7	50.7	52.6
Hylobates klossi ..	♀	N. M. 252310	92	66.7	81.0	100.0	48.0	55.2
Hylobates klossi ..	♀	N. M. 252307	95	70.1	76.3	100.0	50.7	49.1
Hylobates klossi ..	♂	N. M. 122176	85	71.6	75.9	100.0	52.0	51.7
Hylobates klossi ..	♂	N. M. 121674	88	68.4	71.0	106.9	50.7	53.4
Hylobates klossi ..	♂	N. M. 252309	103	67.9	76.2	103.3	48.7	52.5
S. syndactylus ...	♀	N. M. 143581	110	63.5	67.2	103.1	61.5	63.1
S. syndactylus ...	♀	N. M. 114497	112	60.4	65.2	109.4	60.7	61.9
S. syndactylus ...	♀	A. M. 90337	118	62.6	74.6	100.0	63.4	56.7
S. syndactylus ...	♀	N. M. 143580	123	60.7	63.8	103.0	61.5	59.7
S. syndactylus ...	♂	A. S. 130	106	58.1	61.8	111.4	65.8	68.9
S. syndactylus ...	♂	A. M. I 4 C. A.	110	60.4	67.6	112.7	65.5	65.1
S. syndactylus ...	♂	N. M. 114495	115	56.5	63.6	118.5	65.1	63.1
S. syndactylus ...	♂	N. M. 49876	116	58.4	66.7	100.0	63.4	60.6
S. syndactylus ...	♂	N. M. 143577	122	59.8	70.0	109.4	65.9	67.2
S. syndactylus ...	♂	A. M. 549 C. A.	127	61.7	67.5	113.8	60.3	64.6
S. syndactylus ...	♂	N. M. 141160	129	62.0	69.6	101.5	64.3	60.3
S. syndactylus ...	♂	A. S. 265	135	63.7	67.6	107.5	68.3	63.6
S. syndactylus ...	♂	N. M. 171981	136	59.6	66.7	107.4	63.1	59.7
S. syndactylus ...	♂	A. M. 41333	138	61.7	67.5	108.8	65.5	64.7

TABLE III

The Number of Vertebrae in the Different Spinal Regions in Various Species of Hylobates and in Symphalangus syndactylus. All Specimens had 7 Cervical Vertebrae. None of These Specimens Have Been Listed in the Tables V and VI of the Previous Paper by the Author (1930).

SPECIES	COLLECTION	OBSERVED BY	THORACIC	LUMBAR	THOR. L.	SACRAL	COCCYG.	TOTAL
H. cinereus	N. M. 22953	Schultz	13	5	18	5	2	32
H. cinereus	A. M. 80068	Schultz	13	5	18	5	..	..
H. agilis	A. M. 9244	Schultz	13	5	18	5	2	32
H. lar	Cambridge Univ.	Flower, 1888	13	5	18	4	3	32
H. lar	Holland (?)	Fransen, 1907	13	5	18	..	..	..
H. lar	A. M. 752 C. A.	Schultz	12	5	17	5	2	31
H. hoolock	A. M. 43064	Schultz	13	5	18	4	5	34
H. hoolock	A. M. 43065	Schultz	13	5	18	5	3	33
H. hoolock	A. M. 70398	Schultz	13	5	18	4	3	32
H. hoolock	A. M. 15971	Schultz	12	5	17	4	2	30
H. hoolock	A. C.	Schultz	12	5	17	5	..	..
H. leucogenys	J. H. 73	Schultz	13	5	18	4	3	32
H. species ?	A. M. 53976	Schultz	13	5	18	4	2	31
H. klossi	N. M. 121683	Schultz	13	5	18	5	5	35
H. klossi	N. M. 121682	Schultz	13	5	18	5	4	34
H. klossi	N. M. 121693	Schultz	13	5	18	5	4	34
S. syndactylus	A. M. 90337	Schultz	13	4	17	5	2	31
S. syndactylus	A. M. 90268	Schultz	13	4	17	5	3	32
S. syndactylus	M. B.	Schultz	13	4	17	5	3	32
S. syndactylus	N. M. 255980	Schultz	12	4	16	5	4	32
S. syndactylus	Anatomy Zürich	Ruge, 1910	13	5	18	..	..	..

TABLE IV

The Proportions of the Sternum in Hylobatidae (Adult Specimens). New Data Supplementing Those Contained in Table XI of the Previous Paper by the Author (1930).

SPECIES	SEX	COLLECTION	MANUBRIUM + / CORPUS LENGTH	MANUBRIUM LENGTH / CORPUS LENGTH	MANUBRIUM BREADTH / MANUBRIUM LENGTH	CORPUS BREADTH / CORPUS LENGTH
Hylobates cinereus	♀	A. M. 80068	57	58.3	128.5	41.7
Hylobates agilis	♀	A. M. 9244	56	51.3	131.5	35.1
Hylobates lar	♀	A. M. 752 C.A.	62	55.0	140.8	30.0
Hylobates hoolock	?	A. M. 43065	55	52.8	173.6	47.2
Hylobates hoolock	?	A. M. 15971	55	57.1	140.0	31.5
Hylobates hoolock	♀	A. C.	59	59.5	131.7	32.4
Hylobates leucogenys	♀	N. M. 256436	67	36.7	133.3	18.4
Hylobates leucogenys	♂	N. M. 256439	62	51.2	152.3	34.2
Symphalangus syndactylus..	♀	A. M. 90268	40	74.0	135.2	69.6
Symphalangus syndactylus..	♀	A. M. 90337	45	73.1	173.6	69.3
Symphalangus syndactylus..	♂	C. S. 58	53	71.0	190.8	67.7

TABLE V

The Limb Proportions in the Family Hylobatidae. New Data on Adult Specimens, Measured by the Author, Supplementing the Corresponding Data in Table XVI of the Previous Paper by the Author (1930).

SPECIES	SEX	COLLECTION	HUMERUS LENGTH	BRACHIAL INDEX	CRURAL INDEX	INTER-MEMBRAL INDEX
Hylobates lar	♀	A. M. 752 C. A.	249	104.8	85.7	130.7
Hylobates lar	♂	N. M. 111970	252	110.7	86.2	132.0
Hylobates pileatus	♀	J. H. 132	230	110.0	85.4	127.0
Hylobates pileatus	♀	J. H. 122	231	110.3	90.3	123.9
Hylobates pileatus	♀	J. H. 123	232	109.8	86.6	125.5
Hylobates cinereus	♀	A. M. 80068	245	114.7	87.0	128.8
Hylobates cinereus	♂	N. M. 142172	243	109.0	93.5	132.6
Hylobates cinereus	♂	N. M. 22953	244	110.2	89.7	131.7
Hylobates agilis	♀	A. M. 9244	242	118.2	89.3	130.3
Hylobates hoolock	♀	A. M. 43065	228	107.8	86.1	126.0
Hylobates hoolock	♀	A. M. 15971	231	111.2	86.7	125.0
Hylobates hoolock	♀	A. C.	243	109.8	87.7	133.0
Hylobates klossi	♀	N. M. 121680	187	109.6	87.9	120.5
Hylobates klossi	♀	N. M. 121675	197	120.3	88.7	130.6
Hylobates klossi	♀	N. M. 121679	205	115.5	89.4	130.3
Hylobates klossi	♂	N. M. 121688	195	119.0	90.7	123.7
Hylobates klossi	♂	N. M. 121686	200	115.0	87.7	129.4
Hylobates klossi	♂	N. M. 121687	205	118.5	94.0	127.6
Hylobates klossi	♂	N. M. 121678	210	122.8	90.4	124.0
Hylobates klossi	♂	N. M. 121674	215	117.2	91.2	127.2
Symphalangus syndact. ..	♀	A. M. 90337	265	107.8	85.2	145.7
Symphalangus syndact. ..	♂	N. M. 143577	266	113.8	86.9	154.5
Symphalangus syndact. ..	♂	C. S. 58	281	109.2	84.9	145.1

TABLE VI

*List of the Preserved Specimens of the Genus Hylobates. * = Not All Measurements of this Small Embryo Could be Taken. The Fetuses of H. pileatus Whose Catalogue Numbers are Accompanied by an a are from the Adult Mothers with Corresponding Numbers. The Two Adult H. leucogenys are the Parents of the Two Young Male Specimens (Infant I and Juvenile I, Born in Captivity). For Explanation of the Abbreviated Names of the Various Collections See Table 2.*

NO.	SPECIES	AGE	SEX	SITTING HGT. (mm.)	TRUNK HGT. (mm.)	COLLECTION
1	*H. concolor*	embryo	?	21.5	7.0	E. S. 8*
2	*H. concolor*	fetus I	♂	56.0	30.0	E. S. 24 a
3	*H. concolor*	fetus II	♀	92.5	42.6	N. M. 199018
4	*H. concolor*	fetus II	♀	100.0	48.5	N. M. 154410
4a	*H. concolor*	fetus III	♂	145	70	Harvard U.
5	*H. concolor*	fetus III	♀	149	72	N. M. 154412
6	*H. concolor*	fetus III	♀	161	79	N. M. 151977
7	*H. concolor*	infant I	♂	179	91	W. I. 2611
8	*H. concolor*	infant I	♀	207	116	N. M. 154411
9	*H. concolor*	infant II	♂	237	125	E. S. 16 a
10	*H. concolor*	juvenile I	♂	275	162	N. M. 145643
11	*H. concolor*	juvenile II	♂	344	215	N. M. 151976
12	*H. concolor*	adult	♀	408	260	N. M. 255967
13	*H. lar*	infant I	♀	173	86	A. Z. XX
14	*H. lar*	juvenile I	♂	288	170	J. H. 271
15	*H. lar*	juvenile II	♀	372	224	A. Z. 173
16	*H. lar*	juvenile II	♂	385	238	N. M. 253508
17	*H. lar*	juvenile II	♀	385	240	Z. P. .....
18	*H. lar*	adult	♂	414	254	J. H. 261
19	*H. lar*	adult	♀	416	255	N. M. 255903
20	*H. cinereus*	juvenile I	♂	328	193	J. H. 204
21	*H. cinereus*	juvenile I	♀	332	192	J. H. 205
22	*H. cinereus*	juvenile II	♂	353	214	J. H. 182
23	*H. cinereus*	adult	♂	403	252	J. H. 152
24	*H. cinereus*	adult	♂	468	289	J. H. 189
25	*H. pileatus*	fetus II	♂	83	34	J. H. 123 a
26	*H. pileatus*	fetus II	♂	102	50	J. H. 133 a
27	*H. pileatus*	fetus III	♂	158	79	J. H. 132 a
28	*H. pileatus*	fetus III	♂	169	82	J. H. 125 a
29	*H. pileatus*	infant I	♂	198	106	J. H. 121 a
30	*H. pileatus*	infant II	♀	limbs only		J. H. 130
31	*H. pileatus*	juvenile I	♂	limbs & head		J. H. 128
32	*H. pileatus*	juvenile II	♀	limbs & head		J. H. 131
33	*H. pileatus*	adult	♀	limbs & head		J. H. 124
34	*H. pileatus*	adult	♀	limbs & head		J. H. 133
35	*H. pileatus*	adult	♀	limbs & head		J. H. 129
36	*H. pileatus*	adult	♀	limbs & head		J. H. 125

NO.	SPECIES	AGE	SEX	SITTING HGT. (mm.)	TRUNK HGT. (mm.)	COLLECTION
37	*H. pileatus*	adult	♀	limbs only		J. H. 132
38	*H. pileatus*	adult	♀	limbs only		J. H. 122
39	*H. pileatus*	adult	♀	limbs only		J. H. 123
40	*H. pileatus*	adult	♀	limbs & head		J. H. 126
41	*H. pileatus*	adult	♀	limbs & head		J. H. 127
42	*H. agilis*	infant II	♀	252	137	N. M. 113419
43	*H. agilis*	juvenile I	♀	339	200	J. H. 36
44	*H. agilis*	juvenile II	♂	365	216	N. M. 257681
45	*H. leucogenys*	infant I	♂	188	95	N. M. 256087
46	*H. leucogenys*	juvenile I	♂	314	185	N. M. 256088
47	*H. leucogenys*	juvenile II	♀	337	211	J. H. 73
48	*H. leucogenys*	adult	♀	438	273	N. M. 256436
49	*H. leucogenys*	adult	♂	462	284	N. M. 256439
50	*H. klossi*	fetus III	♀	145	71	N. M. 121885
51	*H. klossi*	infant I	♀	203	104	N. M. 121693
52	*H. klossi*	infant II	♂	211	115	N. M. 121683
53	*H. klossi*	juvenile I	♀	239	124	N. M. 121682

TABLE VII

*List of the Preserved Specimens of the Genus Symphalangus. * = Dr. W. L. Straus, Jr. has Kindly Taken a Few Measurements on This Fetus in the Anatomy Department of the University of Amsterdam. For Explanation of the Abbreviated Names of the Various Collections See Table 2.*

NO.	SPECIES	AGE	SEX	SITTING HGT. (mm.)	TRUNK HGT. (mm.)	COLLECTION
54	*S. syndactylus* ...	fetus III	♂	168	88	Amsterdam *
55	*S. syndactylus* ...	infant I	♂	181	96	N. M. 115678
56	*S. syndactylus* ...	infant II	♂	285	144	A. Z. 192
57	*S. syndactylus* ...	juvenile I	♂	378	221	A. Z. 978
58	*S. syndactylus* ...	juvenile I	♀	381	204	A. M. 604
59	*S. syndactylus* ...	juvenile II	♂	423	248	N. M. 255980
60	*S. syndactylus* ...	juvenile II	♂	434	254	A. Z. 238
61	*S. syndactylus* ...	adult	♀	438	256	A. Z. 197
62	*S. syndactylus* ...	adult	♀	463	280	A. Z. 496
63	*S. syndactylus* ...	adult	♂	468	284	A. Z. 497
64	*S. syndactylus* ...	adult	♂	478	303	A. Z. 189
65	*S. syndactylus* ...	adult	♂	483	298	A. Z. 191
66	*S. syndactylus* ...	adult	♂	489	297	A. Z. 188
67	*S. syndactylus* ...	adult	♂	492	302	A. Z. 122
68	*S. syndactylus* ...	adult	♀	499	313	Z. L. 31/39

STUDIES IN GROWTH II

BY FRANZ BOAS

At the time when the previous publication [1] on this subject was completed no observations on the boys of Horace Mann School were available. These are given in the following notes. In a second part of the present paper will be found several remarks on the average age of adolescence which seem necessary to meet possible objections to the values given in the previous paper. In a third part I give results on the correlation of dentition and total growth.

TABLE 1

Horace Mann School Boys
Mean and Variability of Stature at Each Age

Dr. Hellman's Records *
Mean Stature at Each Age for those Records with Beginning of Stage III B, III C, or IV A Given

	HEBREW		NON-HEBREW		BOYS		GIRLS	
Age Years	Mean and σ	Cases	Mean and σ	Cases	Mean and σ	Cases	Mean and σ	Cases
4	101.6±4.0	16	104.5±3.7	43	.....	..	.....	..
5	110.3±5.2	51	110.8±3.7	110	.....	..	.....	..
6	116.6±5.1	77	116.5±4.5	187	120.6	5	119.1	14
7	122.8±5.0	104	122.6±4.8	274	126.2±5.4	21	125.7±3.5	32
8	128.5±5.2	113	128.0±5.1	316	131.3±5.8	39	131.3±5.0	55
9	133.5±5.3	125	133.3±5.1	330	136.7±6.4	66	135.9±5.5	80
10	138.4±5.7	126	138.4±5.1	340	141.7±6.7	74	141.0±6.0	89
11	143.3±6.3	124	143.1±5.4	346	146.0±7.0	73	146.8±6.9	88
12	147.6±6.8	113	147.2±5.8	286	150.6±7.4	66	152.7±6.8	81
13	152.3±7.8	109	152.0±6.3	258	157.0±8.3	58	158.2±6.1	64
14	158.1±8.2	106	159.0±7.6	254	163.6±8.8	51	162.3±6.0	53
15	165.2±8.1	104	165.5±7.6	251	170.4±8.2	37	163.3±5.4	44
16	170.1±7.6	89	170.5±6.8	241	174.0±5.6	19	164.3±6.4	31
17	172.7±6.7	64	173.7±6.6	189	175.3	13	164.6±5.6	19
18	173.8±6.3	32	174.7±6.1	97	177.0	10	163.8	11
19	171.8	8	176.5±6.6	36	174.0	3	164.1	8
20	174.0	2	176.1	7	.....	..	.....	..
21	174.0	2	176.8	3	.....	..	.....	..

* For description of series, see p. 441.

[1] Studies in Growth, HUMAN BIOLOGY, Vol. IV, pp. 307-350.

I

The statures of Horace Mann School [2] boys, Hebrew and non-Hebrew, are given in Table 1. It appears that the boys exceed the Newark Academy boys [3] by a considerable amount throughout the whole period of growth and the non-Hebrews also as adults. Whether or not the average values for the Newark Academy have increased since the time when the measurements were taken from 1870 to 1898 has not been determined. Until their eighth year the H. M. Hebrew boys are rather shorter than those in the Ethical Culture School [4] measured at an earlier period (about 1910). After that time they exceed them at an increasing rate. In the present series the Hebrew boys are slightly taller than the non-Hebrew boys from the sixth year until the thirteenth year. After that time they lag slightly as in all the other series. The table repeatedly referred to shows that the same relation prevailed among boys, Hebrew and non-Hebrew, when City College (column 6), Ethical Culture School (column 2), and Newark Academy (column 3) are compared. The H. M. girls, Hebrew and non-Hebrew [5] showed throughout a slightly lower stature for the Hebrews, while a comparison of Hebrew Ethical Culture School and the non-Hebrew H. M. showed the Hebrew girls until the tenth year slightly taller than the non-Hebrew H. M. girls, and an increasing lagging of the Hebrew girls after this date. An analysis of this phenomenon showed that young and short City College boys (mostly Hebrew) grow more than the non-Hebrew Newark Academy boys and that the period of excess for City College boys lasts the longer, the shorter the boys at the initial period.[6] No clear evidence of any such relation could be obtained from the H. M. data on boys.

A comparison of Hebrew and non-Hebrew H. M. boys as well as girls, when arranged in classes according to their maximum rate of growth [7] shows very decided differences in behavior of the growth curves for each class. During the years when the greatest number of cases are available, there are the same children in each class, while the different classes contain different children. Since the total number of children is small and there may be changes in the composition of the

[2] Hereafter abbreviated H. M.
[3] *Ibid.*, p. 314, Table 5a, 3rd column.
[4] *Ibid.*, p. 314, Table 5a, 2nd column.
[5] *Ibid.*, p. 315, columns 5 and 6.
[6] *Ibid.*, pp. 316-318.
[7] *Ibid.*, Table 7a, 7b, pp. 319, 320.

classes they are not strictly comparable, and it is not possible to draw the general inference that the growth of Hebrews and non-Hebrews follows different laws, although further investigations of the question seem worth while.

In Table 2a I give the differences between Hebrew and non-Hebrew H. M. girls according to Table 7 of the publication referred to, arranged according to the year of maximum rate of growth, but only for those years in which the same girls have been observed consecutively during the whole period here recorded. Negative values mean that the Hebrew girls are shorter than the non-Hebrew girls.

For boys the number of cases is very inadequate; still I give it here.

The measurements of statures for H. M. boys for various periods of maximum rate of growth are given in Table 3 (corresponding to Table 8 of the preceding paper).

The reduction in variability of the boys is again noticeable, although not as well pronounced as in the girls (Table 4).

TABLE 2a

Differences Between Hebrew and Non-Hebrew H. M. Girls

MAX. GROWTH RATE	AGES							NUMBER OF CASES	
	9	10	11	12	13	14	15	Hebrew	Non-Hebrew
10-11	—3.8	—4.4	—4.7	—5.0	....	....	....	22	44
11-12	....	+ .6	+ .3	+ .2	+ .1	....	....	60	101
12-13	....	....	—1.8	—2.2	—2.3	—2.3	—2.3	63	86
13-14	....	....	....	— .2	— .1	— .4	— .6	36	49

TABLE 2b

Differences Between Hebrew and Non-Hebrew H. M. Boys

MAX. GROWTH RATE	AGES					NUMBER OF CASES	
	12	13	14	15	16	Hebrew	Non-Hebrew
12-13	— .7	— .4	+ .5	+3.4	....	17	12
13-14	—1.4	—1.8	—2.2	—2.2	....	18	44
14-15	+1.5	+ .6	+ .7	+ .2	.0	23	54
15-16	....	....	—1.8	—2.2	—2.4	9	21

TABLE 3a

Horace Mann School Non-Hebrew Boys

Mean and Variability of Stature at Each Age for Those Having Maximum Rate of Growth at Same Age Interval

TIME OF MAX. GROWTH	AGE																	
	4 yrs.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
10-11	....	....	118.6	124.5	126.2	129.6	135.2	143.4	149.8	154.1	....	....	....	....	....	....	....	....
Years	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	..	..	1	1	2	2	2	2	2	2	..	..	..	..	..	..	..	..
11-12	....	....	119.4	126.3	130.8	136.6	142.2	148.9	157.7	165.0	170.0	172.0	179.1	180.5	....	....	....	....
	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	..	..	1	2	3	3	3	3	3	3	3	3	2	2	..	..	..	..
12-13	....	....	....	127.0	129.3	134.6	140.9	146.1	152.1	161.0	166.9	169.0	170.6	171.2	171.1	166.2	....	....
	....	....	....	....	....	....	±4.5	±4.7	±5.9	±6.4	±6.2	±5.3	....	....	....	....	....	....
	..	..	..	3	6	8	10	12	12	12	12	11	9	7	2	1	..	..
13-14	103.0	110.1	115.9	122.9	128.4	133.9	138.5	142.9	147.5	153.6	162.2	168.7	172.8	174.6	174.2	176.0	183.7	....
	....	....	±6.8	±4.6	±4.3	±4.2	±4.6	±4.9	±5.1	±5.3	±5.5	±5.6	±5.5	±5.1	±4.5	....	....	....
	1	5	12	19	28	31	34	38	44	44	44	43	37	27	10	5	1	..
14-15	....	....	115.3	121.6	125.8	130.7	136.4	141.7	145.5	150.6	157.0	165.6	171.2	173.7	174.6	177.3	178.4	178.8
	....	....	....	±5.4	±6.3	±6.2	±5.5	±5.6	±6.1	±6.3	±6.7	±7.1	±6.6	±7.1	±7.5	....	....	....
	..	..	9	13	16	20	30	40	47	53	54	54	53	38	18	6	2	2
15-16	....	....	115.0	122.2	127.5	133.6	138.4	142.1	145.7	149.9	155.5	162.3	170.0	175.2	175.4	173.3	....	....
	....	....	....	....	....	±4.2	±4.4	±4.2	±4.3	±4.8	±4.9	±5.1	±5.0	±5.0	±4.2	....	....	....
	..	..	3	7	8	10	12	16	17	19	21	21	21	20	10	2	..	..
16-17	....	109.4	114.4	122.7	128.8	134.2	137.5	141.0	144.3	148.4	151.4	156.8	162.9	171.4	176.5	171.2	171.9	172.1
	....	....	....	....	....	....	....	....	....	....	±5.3	±5.7	±6.0	±5.9	....	....	....	....
	..	1	1	4	4	5	6	8	8	9	11	12	12	12	7	1	1	1

	..	1	1	4	4	5	6	8	8	9	11	12	12	12	7	1	1	1

TABLE 3b

Horace Mann School Hebrew Boys

Mean and Variability of Stature at Each Age for Those Having Maximum Rate of Growth at Same Age Interval

TIME OF	AGE																	
MAX. GROWTH	4 yrs.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
12-13	....	110.1	118.3	125.5	131.1	137.1	141.2	146.6	151.4	160.6	167.4	172.4	174.7	175.9	173.6	169.9	....	....
Years	....	....	....	....	....	±4.0	±5.6	±5.8	±7.3	±7.6	±7.6	±6.7	±7.0	....	....	....	....	....
	..	2	4	7	9	10	13	13	17	17	17	16	14	9	4	2	..	..
13-14	106.1	111.5	115.0	121.7	127.7	132.9	137.1	141.6	146.1	151.8	160.0	166.5	170.9	173.1	177.0	173.3	174.6	174.8
	....	....	....	±4.7	±4.5	±4.5	±4.7	±4.9	±4.7	±5.1	±4.8	±4.9	±4.3	±5.0	....	....	....	....
	1	3	6	12	13	15	16	17	18	18	18	18	16	11	6	2	1	1
14-15	105.5	110.3	117.9	123.4	129.0	133.4	138.9	143.1	147.0	151.2	157.7	165.8	171.2	175.4	175.9	....	....	....
	....	....	....	±4.5	±4.7	±5.2	±5.4	±5.5	±6.1	±6.7	±6.4	±6.1	±5.6	±3.8	....	....	....	....
	1	4	8	11	12	19	18	20	21	23	23	23	22	15	6	..	..	..
15-16	....	....	115.0	122.1	126.1	131.3	135.8	140.3	145.1	149.1	153.7	160.1	167.6	171.8	172.7	167.8	....	....
	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	..	..	3	7	8	8	8	8	9	9	9	9	9	8	5	1	..	..
16-17	....	106.9	110.1	117.1	121.9	127.8	132.9	137.4	141.2	145.2	149.0	154.3	161.2	169.6	174.0	....	....	....
	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	..	2	3	5	5	5	5	5	6	6	6	6	6	6	1	..	..	..

TABLE 4

Maximum Variabilities and Their Excesses Over the Variabilities of Adjoining Years

AGE OF MAX. RATE OF GROWTH	—4 YRS.	—3 YRS.	—2 YRS.	—1 YR.	MAX.	+1 YR.	+2 YRS.	+3 YRS.	+4 YRS.
Total Hebrews....	—2.5	—1.9	—1.4	— .4	8.2 (at 14)	— .1	— .6	—1.5	—1.9
Total Non-Hebrews	—2.2	—1.8	—1.3	— .0	7.6 (at 15)	— .1	— .8	—1.0	—1.5
Maximum Rate 13-14	— .7	— .5	— .3	— .1	5.6	— .1	— .5	—1.1	....
Maximum Rate 14-15	—1.5	—1.0	— .8	— .4	7.1	— .5	+ .0	....	....
Maximum Rate 15-16	— .9	— .8	— .3	— .2	5.1	— .1	— .1	....	....

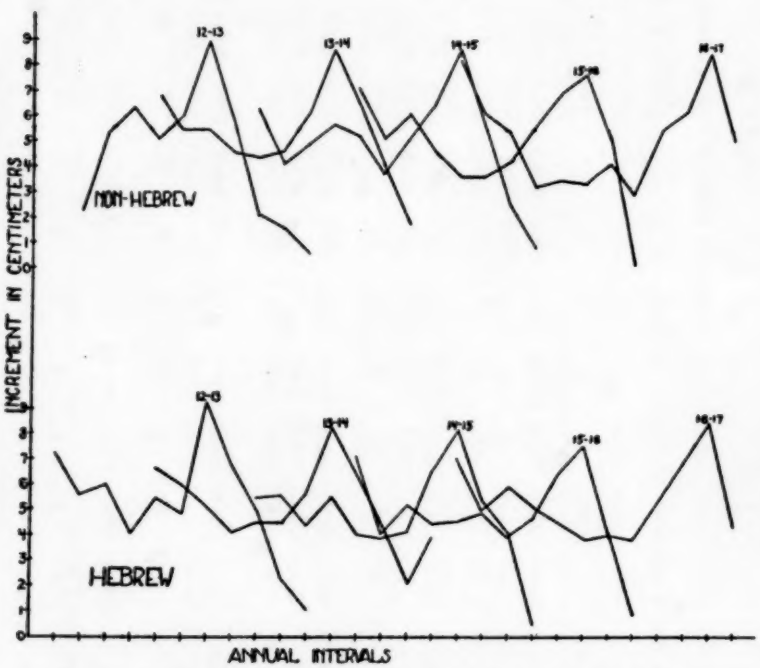

FIG. 1. RATIO OF ANNUAL INCREMENT FOR HORACE MANN SCHOOL BOYS HAVING MAXIMUM RATE OF GROWTH AT VARIOUS PERIODS

The total amount of growth of the H. M. boys as given in various intervals around the time of maximum rate of growth confirms the previous observation, that the intensity of growth is the less, the later the maximum rate. It is remarkable that notwithstanding the greater absolute stature of the H. M. boys the growth around the period of maximum rate is lower than that of the Newark and City College boys (Table 5; compare Table 13*b* of the previous publication). Notwithstanding the small number of cases the decreased intensity of growth for those with late adolescence appears fairly clearly (Table 6, fig. 1).

There are not enough cases to permit a convincing analysis of the growth of boys who have the same stature in a given year. The only one giving tolerable results is the one for stature between 145 and 150 at 12 years; however the series does not extend far enough in age to show convincingly that the adults of the series will be shorter the earlier their period of maximum rate of growth.

TABLE 5

Total Increment in Stature During Various Intervals Around the Period of Maximum Growth

Horace Mann School Boys

PERIOD OF MAX. GROWTH	INTERVAL AROUND PERIOD OF MAX. GROWTH					
	— .5 to + .5	—1.5 to +1.5	—2.5 to +2.5	—3.5 to +3.5	—4.5 to +4.5	
12-13 Yrs.	8.9	20.8	28.1	36.0	41.9	Non-Hebrew
	9.2	20.8	31.2	37.6	44.8	Hebrew
13-14	8.6	21.2	29.9	36.1	...	Non-Hebrew
	8.2	20.4	29.3	36.0	44.1	Hebrew
14-15	8.6	20.6	28.2	32.9	...	Non-Hebrew
	8.1	20.0	28.4	32.8	...	Hebrew
15-16	7.7	19.7	25.5	...	...	Non-Hebrew
	7.5	18.1	23.6	...	...	Hebrew
16-17	8.5	19.7	...	...	...	Non-Hebrew
	8.4	19.7	...	...	...	Hebrew

TABLE 6

Mean Increment at Each Age of Horace Mann School Boys With Same Time of Acceleration

TIME OF MAX. GROWTH	NON-HEBREW BOYS											
	6-7yrs.	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
12-13	..	2.3	5.3	6.3	5.2	6.0	*8.9*	5.9	2.1	1.6	.6	..
	..	3	6	8	10	12	12	12	11	9	7	..
13-14	7.0	5.5	5.5	4.6	4.4	4.6	6.1	*8.6*	6.5	4.1	1.8	..
	12	19	28	31	34	38	44	44	43	37	27	..
14-15	6.3	4.2	4.9	5.7	5.3	3.8	5.1	6.4	*8.6*	5.6	2.5	.9
	9	13	16	20	30	40	47	53	54	53	38	18
15-16	7.2	5.3	6.1	4.8	3.7	3.6	4.2	5.6	6.8	*7.7*	5.2	.2
	3	7	8	10	12	16	17	19	21	21	20	10
16-17	8.3	6.1	5.4	3.3	3.5	3.3	4.1	3.0	5.4	6.1	*8.5*	5.1
	1	4	4	5	6	8	8	9	11	12	12	7

TIME OF MAX. GROWTH	HEBREW BOYS											
	6-7yrs.	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
12-13	7.2	5.6	6.0	4.1	5.4	4.8	*9.2*	6.8	5.0	2.3	1.2	..
	4	7	9	10	13	13	17	17	16	14	9	..
13-14	6.7	6.0	5.2	4.2	4.5	4.5	5.7	*8.2*	6.5	4.4	2.2	3.9
	6	12	13	15	16	17	18	18	18	16	11	6
14-15	5.5	5.6	4.4	5.5	4.2	3.9	4.2	6.5	*8.1*	5.4	4.2	.5
	8	11	12	18	18	20	21	23	23	22	15	6
15-16	7.1	4.0	5.2	4.5	4.5	4.8	4.0	4.6	6.4	*7.5*	4.2	.9
	3	7	8	8	8	8	9	9	9	9	8	5
16-17	7.0	4.8	5.9	5.1	4.5	3.8	4.0	3.8	5.3	6.9	*8.4*	4.4
	3	5	5	5	5	5	6	6	6	6	6	1

II

It seems desirable to add a word in regard to the average ages of first menstruation and maximum rate of growth given in the previous paper (pp. 309, 310). A difficulty arises in these determinations because the observations on a certain number of children are incomplete. They

either enter school after the moment to be determined, or leave before it is reached. Therefore, the absolute number of cases for each interval of time is not always the same. Unfortunately this cannot be remedied by reducing the absolute number to percentages, because a considerable number of children for whom measurement records are available were not observed in regard to time of first menstruation. This can be remedied only by confining the tabulation to those who have been observed the whole period from 10 to 16 years in which the first menstruation normally occurs. The few cases outside of these limits have to be disregarded.

Table 7 gives the date of first menstruation for all those who have been observed continuously from 10 to 16 years inclusive.

The values obtained by this more rigid method do not differ significantly from those given on p. 309 of the previous paper, except that for this group there is no difference between the Hebrew Orphan Asylum and Horace Mann School.

The same check should be applied to the period of maximum rate of growth. The results are given in the following table.

TABLE 7

Time of First Menstruation of Girls for Those Continuously Observed from 10 to 16 Years

	HORACE MANN SCHOOL		HEBREW
AGE IN YEARS	Non-Hebrew	Hebrew	ORPHAN ASYLUM
9.5- 9.99	1	..	..
10.0-10.49	1	..	..
10.5-10.99	1	1	1
11.0-11.49	..	1	1
11.5-11.99	5	3	4
12.0-12.49	7	1	4
12.5-12.99	5	8	11
13.0-13.49	6	8	10
13.5-13.99	3	5	14
14.0-14.49	5	2	10
14.5-14.99	1	3	8
15.0-15.49	3	4	..
15.5-15.99	1	1	1
16.0-16.49	2	..	..
16.5-16.99	1	..	..
Averages	13.3±1.6	13.4±1.2	13.4±1.0
Number of cases	42	37	64

Boys enter City College not younger than 12 years. Hence the first maximum rate of growth that can be determined is for the interval between 13 and 14 years and for this the number of cases is small. For continuous records from 12 to 17 years the distribution of maximum rates is as follows:

13-14	22
14-15	17
15-16	3
16-17	4

It would seem from this that the average age is lower than 14.7 as given in the previous paper.

TABLE 8

Time of Maximum Rate of Growth of H. M. Boys and Girls for All of Those Continuously Observed From 9 to 18 Years for Boys, From 8 to 17 Years for Girls

AGE OF MAX. RATE OF GROWTH	BOYS		GIRLS	
	Non-Hebrew	Hebrew	Non-Hebrew	Hebrew
9-10	..	..	1	..
10-11	..	..	17	16
11-12	..	..	46	30
12-13	..	1	43	32
13-14	6	6	18	18
14-15	9	6	1	..
15-16	5	5	..	..
16-17	2	1	..	..
Averages	14.6± .9	14.4±1.0	12.0± .9	12.0±1.0
Number of cases	22	19	126	96

III

DEVELOPMENT OF TEETH AND GROWTH

There are a number of contradictory observations in regard to the interrelation between development of teeth and bodily growth. Spier found in a study of material collected by me in Porto Rico,[8] that there is a relation between stature and the stage of dentition, so that those more advanced in dentition have the higher stature. I found the same

[8] Leslie Spier, The growth of boys, dentition and stature, *American Anthropologist*, NS 20: 37 et seq.

in Hebrew infants.[9] On the other hand, a comparison of the time of eruption among the poor and well-to-do showed that the permanent dentition of the poor who are shorter than the well-to-do, proceeds, except for the incisors, more rapidly, so that in a socially mixed group containing many economically poorly situated children there is the reverse relation. This appears from the following table arranged from Dr. Hellman's data (Table 9).[10] The time of shedding for the poor is given by the amount to be added to that found among the well-to-do. The stature is given here for the nearest year.

TABLE 9

Average Time of Shedding of Teeth and Average Stature

		SHEDDING OF TEETH		STATURE AT NEAREST FULL YEAR	
		Wealthy	Poor	Wealthy	Poor
		Boys			
Central Incisor	Upper	7.1	+ .0	124.6 cm.	—7.2 cm.
	Lower	6.4	+ .2	117.7 cm.	—8.8 cm.
Lateral Incisor	Upper	8.2	+ .3	128.4 cm.	—8.0 cm.
	Lower	7.4	+ .3	124.6 cm.	—7.2 cm.
Canine	Upper	11.5	— .2	141.0 cm.	—7.6 cm.
	Lower	10.6	+ .4	141.0 cm.	—7.6 cm.
Pre-molar I	Upper	10.7	—1.3	141.0 cm.	—7.6 cm.
	Lower	10.8	—2.1	141.0 cm.	—7.6 cm.
Pre-molar II	Upper	11.5	—1.4	141.0 cm.	—7.6 cm.
	Lower	11.7	—2.4	146.0 cm.	—7.9 cm.
		Girls			
Central Incisor	Upper	6.8	+ .4	124.6 cm.	—10.5 cm.
	Lower	6.2	+ .4	118.7 cm.	— 9.0 cm.
Lateral Incisor	Upper	7.6	+ .7	129.6 cm.	—10.0 cm.
	Lower	7.0	+ .6	124.6 cm.	—10.5 cm.
Canine	Upper	10.7	+ .1	142.4 cm.	— 8.4 cm.
	Lower	9.8	0	140.9 cm.	—11.7 cm.
Pre-molar I	Upper	10.3	—1.1	140.9 cm.	—11.7 cm.
	Lower	10.1	—1.3	140.9 cm.	—11.7 cm.
Pre-molar II	Upper	11.1	—1.1	142.4 cm.	— 8.4 cm.
	Lower	10.8	—1.7	142.4 cm.	— 8.4 cm.

[9] Franz Boas, Eruption of deciduous teeth among Hebrew infants, *Journal of Dental Research, VII*, pp. 245 et seq.

[10] Milo Hellman, Nutrition, growth and dentition, *Dental Cosmos*, January 1923.

John C. Gebhart has pointed out [11] that poor Italians agree in the time of shedding teeth with Dr. Hellman's series of poor children.

I give here incidentally the average ages of eruption of teeth of Zulu children as computed from observations made by Dr. V. Suk.[12] The ages are said by the author to be reliable. I have added the differences between Zulu and Dr. Hellman's poor series.

TABLE 10

Eruption of Permanent Teeth Among Zulus
Mean and Variability of Time of Eruption

Males

	UPPER JAW			LOWER JAW		
	Right	Diff.*	Left	Right	Diff.	Left
Ic	5.8±1.25	—1.4	5.8±1.25	5.0± .92	—1.6	5.0±1.05
Il	6.8±1.97	—1.6	6.7±1.50	5.7±1.24	—2.0	6.0± .97
C	10.3±1.63	—1.0	10.1±1.39	9.5±1.28	—1.5	9.5±1.37
PI	9.6±1.35	+ .2	9.6±1.30	9.7±1.29	+1.0	9.8±1.29
PII	10.2±1.12	+ .1	10.2±1.06	10.3±1.31	+1.0	10.2±1.30
MII	11.0±1.34	....	11.1±1.31	10.8±1.39	....	10.7±1.49
MIII	17.0±1.21	....	17.1±1.28	17.2±1.53	....	17.0±1.67

Females

	UPPER JAW			LOWER JAW		
	Right	Diff.*	Left	Right	Diff.	Left
Ic	5.8±1.25	—1.4	5.8±1.25	5.3± .69	—1.2	5.3± .69
Il	7.1±1.26	—1.2	7.0±1.53	5.9±1.09	—1.7	6.2±1.27
C	9.6±1.59	—1.2	9.4±1.31	8.9±1.39	—1.1	9.1±1.63
PI	9.3±1.20	— .2	9.3±1.26	9.3±1.09	+ .5	9.4±1.08
PII	9.4±1.52	— .6	9.5±1.67	9.6±1.38	+ .5	9.7±1.7
MII	10.5±1.14	....	10.6±1.31	10.5±1.43	....	10.5±1.33
MIII	18.0±1.70	....	18.0±1.68	17.3±2.02	....	17.3±1.93

* Negative values in the column of Differences indicate that the teeth among the Zulu erupt earlier than among the poor White; positive values that they erupt later.

[11] The growth and development of Italian children in New York City. *New York Association for Improving the Condition of the Poor. Publication* 132, p. 24.

[12] V. Suk, Eruption and decay of permanent teeth in whites and negroes, with comparative remarks on other races, *Amer. Jour. of Phys. Anthropology*, 2 (1920) : 1-33.

It will be noticed that for incisors and canines the Zulu have much earlier times for the eruption of the permanent set, while for the first and second pre-molars, the only ones for which comparative material is available, the order changes, the development among the Zulu being later than among the poor of New York. This parallels to a more marked degree what was found in comparing well-to-do and poor. The poor are slightly accelerated in early years (the Zulu much), while later on they are considerably retarded. It seems, therefore, plausible that we have in the Zulu series a mixture of racial and environmental effects which require for their disentanglement observations on Zulu living under different conditions.

Dr. Hellman had the great kindness to place his original material at my disposal. His material is classified as follows:

I	A	All deciduous teeth erupted except P II
	C	P II starts erupting
II	A	All deciduous teeth erupted
	B	Central permanent incisors erupting
	C	First molar erupting
III	A	Three or more first molars erupted
	B	Permanent canine, P I or P II erupting
	C	M II erupting
IV	A	Three or more M II erupted
	C	M III erupted
V	A	Three or more M III erupted

Many of his subjects have been observed continuously for a number of years. From these continuous observations many of which were taken at short intervals the following dates for the beginning of each stage have been calculated.[13]

TABLE 11

Ages at Which Stages of Dental Development Begin

STAGE	BOYS		GIRLS	
	Age	Cases	Age	Cases
II C	6.4	(13)	7.1	(7)
III A	7.0± .9	(27)	7.7	(16)
III B	9.5±1.0	(74)	9.8±1.1	(68)
III C	11.5±1.1	(64)	11.8±1.1	(50)
IV A	12.7±1.4	(57)	12.9±1.3	(56)
IV C	17.4	(3)	17.6	(8)

[13] Only those in which the transition from one stage to the next could be dated have been used.

It appears here again that the dentition of the sexes proceeds very nearly at the same rate, which indicates that there is no close relation between the causes controlling dentition and sexual maturity.

The average time each stage lasts may be obtained by subtracting the average initial times of two subsequent stages.

The data are not sufficient to show whether there is a relation between the age at which a certain stage is reached and its duration.

A relation between the time when a certain stage is reached and the time of maximum rate of growth can be determined, although not with great accuracy. This is partly due to the small number of cases, partly to the inexactness of the definition of the two phenomena, both of which admit uncertainties of several months. The following table gives the available data.

TABLE 12

Correlation Table Between Age at Which Stages of Dental Development are Reached and Age of Maximum Rate of Growth

STAGES REACHED AT AGE		TIME OF MAXIMUM RATE OF GROWTH								
		Boys				Girls				
		12-13	13-14	14-15	15-16	9-10	10-11	11-12	12-13	13-14
III B	8.5	..	..	..	..	..	1	..	2	..
	9.5	..	2	1	..	1	4	2	3	1
	10.5	..	4	..	..	..	3	1	2	..
	11.5	..	2	1	..	..	..	..	..	1
	12.5	..	..	..	..	..	..	..	..	..
	13.5	1	..	..	..	..	..	..	..	..
	14.5	..	1	..	..	..	..	..	..	..
III C	9.5	..	..	..	..	..	..	..	1	..
	10.5	1	..	..	..	..	..	1	..	..
	11.5	2	2	..	1	..	7	1	7	1
	12.5	..	3	1	..	..	..	1	2	1
	13.5	..	2	1	..	..	..	..	..	1
	14.5	..	..	..	..	..	..	..	1	..
IV A	10.5	..	..	..	..	1	1	..	1	..
	11.5	1	1	..	..	..	..	1	2	..
	12.5	..	1	..	..	..	2	2	4	1
	13.5	4	3	1	2	..	2	..	3	1
	14.5	..	..	3	..	..	..	..	2	1
	15.5	..	1	..	1	..	..	..	..	..

These data may be summarized as follows:

		BOYS	GIRLS
III B	reached at	$9.7 + .1t$	$10.8 + .1t$
III C	reached at	$11.8 + .3t$	$12.2 + .4t$
IV A	reached at	$12.6 + .4t$	$13.6 + .4t$

when t designates the deviation in years from the average time of maximum rate of growth. For the stage III B the relation seems to be very slight, for the later stages much greater.

The relation between stage of dentition and stature is clear notwithstanding the lack of sufficient number of cases. I give here a table showing the data for the ages at which various stages are reached; with the corresponding average stature for Dr. Hellman's series.

TABLE 13

Stature at Each Age Corresponding to the Ages When Stages III B, III C, IV A are Reached

AGE WHEN STAGE REACHED	BOYS			GIRLS		
	III B	III C	IV A	III B	III C	IV A
9- 9.9	137.9(22)	135.4 (2)	.....	136.4(26)	135.4 (4)	.....
10-10.9	139.4(16)	143.8 (9)	145.8 (6)	137.7(19)	141.5(14)	146.3 (5)
11-11.9	143.8 (9)	146.3(14)	150.6 (7)	136.7 (2)	148.3(25)	149.6(14)
12-12.9	.....	148.8(17)	153.4(12)	151.6 (2)	148.8(12)	152.9(18)
13-13.9	.....	153.4 (7)	156.0(17)	.....	153.7 (5)	157.0 (9)

TABLE 14

Average Deviation of Stature of Annual Averages from 8 to 14 Years for Those Reaching Stages III B, III C, IV A at Different Periods

	BOYS			GIRLS		
	III B	III C	IV A	III B	III C	IV A
8- 8.9	— .8	....	....	3.0	....	....
9- 9.9	2.5	3.3	....	.8	....	....
10-10.9	—2.1	1.2	....	—3.3	1.0	3.5
11-11.9	—2.7	—1.6	5.9	....	.9	1.1
12-12.9	....	—1.4	2.3	....	—2.7	— .6
13-13.9	....	....	—1.5	....	....	—2.2
14-14.9	....	....	—4.8	....	....	....

This table shows that the earlier a stage of dentition is attained, the greater is the stature for that particular year.

I have also tabulated these data in such a way as to give for the ages from 8 to 14 years the average excesses of stature over the average stature of these years for those children for whom the beginnings of stages III B, III C, and IV A have been recorded. In this way some of the difficulties caused by the small number of cases may be obviated, although it must be remembered that to a certain extent the same children are contained in each age group.

All these data agree and prove that in a homogeneous social group early dentition is related to early increase in stature.

HEIGHT AND WEIGHTS OF AMERICAN COLLEGE MEN*

BY HAROLD S. DIEHL, M. D., M. A.
Minneapolis, Minnesota

For many years college students have been weighed and measured, and I judge that the usual reason for making these measurements has been that they might serve as a basis for giving health advice and for assigning students to appropriate programs of physical activity. To be useful for such purposes, however, it is necessary not only to know an individual's height and weight but also to judge whether the deviation of these measurements from the average or normal is sufficiently great to be of importance.

When considering an extremely overweight individual, a glance at the recorded height or weight, or better still at the individual himself, serves as an adequate basis upon which to pass judgment concerning the state of his nutrition, but with less extreme deviations from the average it becomes necessary to compare the individual's height and weight with some sort of an accepted standard of normal. Unfortunately, however, there are so many factors which may influence growth that it is not possible to say just what is normal or abnormal weight or height for any individual. For large groups the mean, or average, heights and weights are statistically reliable and it has become common practice to use such group averages as standards with which to compare individual cases. For this purpose, several so-called standard tables of average weight for various ages and heights have been prepared. Of these the most widely used are the Baldwin-Wood tables for school age children (1) and the medico-actuarial tables for adults (2). In work with college students the latter tables have been adopted almost exclusively because the ages of many students are greater than those covered by the Baldwin-Wood tables.

These medico-actuarial tables, which were compiled from the measurements of a large number of individuals, present thoroughly

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reliable averages for height and weight according to age; but since they were made in connection with life insurance examinations and so include shoes and indoor clothing, the question naturally arises as to whether these are satisfactory standards to use for college students who are usually weighed without either shoes or clothing. At the University of Minnesota, as well as at certain other colleges, it has been the practice to record on the physical examination blanks after the actual height and weight the percentage relationship of the weight to the standard (average) as given in the medico-actuarial tables for that particular age and height. For example, if a boy is 19 years of age, 5 feet 9 inches tall and weighs 128 pounds, his weight is 88 per cent of this so-called standard. The recording of this percentage relationship makes it easier for an examining physician to be consistent in judging the relative weights of individuals than would be possible if he had before him only actual heights in inches and weights in pounds.

Clearly the use of standard tables is helpful but a question always in the background and frequently raised is how satisfactory are the available tables when used for making comparisons with stripped heights and weights of a rather selected group of young adults. It was for the purpose of securing some accurate information on this question that this study was undertaken. As it has progressed, however, the data have presented other problems of differences and relationships which have been analyzed and discussed.

COLLECTION OF DATA

Although certain height and weight measurements of college students have been carefully recorded and published from time to time since about 1900,[1] it seemed that the data to be used for building new tables of height and weight for college men and women should consist of measurements taken at approximately the same time, in colleges and universities of different types and well distributed throughout the country. Accordingly, certain institutions, large co-educational universities and smaller private colleges for men and for women, located in the north, south, east, and west were selected for the study, and if during the academic years 1928-29 and 1929-30 the heights and weights of their students had been measured and the data recorded according to the

[1] For complete bibliography of the measurement of college students see paper by C. M. Jackson (3).

specifications adopted for the study, they were invited to tabulate and submit the records of the age, height and weight of approximately 2500 boys, or girls or both. The conditions specified were that age should be recorded in years and months or in years to the nearest birthday, that height should be measured without shoes, by means of an arm projecting at a right angle from the vertical plane and sufficiently firm to give accurate readings, that height should be recorded in inches and fractions of an inch; that weight should be taken without clothing on a standardized scale and that weight should be recorded in pounds and fractions of a pound. If an examining gown was used the weight of this was deducted from the total weight given. The selection of institutions was somewhat random except for the type of institution and the geographical location. Of the institutions invited to coöperate in the study, a few did not have the data in the form requested and some found it inconvenient to make the tabulations. For the most part, however, a distinct interest was expressed in the study and the best of coöperation received. Records for men were received from the ten following institutions: the Universities of California, Cincinnati, Cornell, Minnesota, Princeton, Leland Stanford, Texas, Wisconsin and Yale and from the College of the City of New York. The total number of records included in the tabulation for men was 23,122.

Method of Tabulation

Scattergrams according to height in inches to the nearest inch and weight in pounds to the nearest pound were made for each age group of each college. Halves in years, inches or pounds were thrown alternately to the group above and the group below the half. From these scattergrams or combinations of them, various statistical constants were computed.

Problems Studied

As previously stated, the original purpose of this study was to build age-height-weight tables for college students and to compare these with the tables now used as standards. In the compilation of these tables, however, it appeared that there were distinct differences between the statures and the weights of students of the different colleges. These differences have been studied statistically. Finally, the heights, the weights, and the correlations between height and weight of these college students have been compared with similar measures of other groups in the population.

ENTIRE GROUP OF COLLEGE MEN

The scattergrams for the individual colleges were combined for each age and from these the calculations were made which are presented in tables 1 to 7. Table 1 includes all the students between 16 and 21 years of age and gives the number of cases for each inch in height, their mean weights, the probable errors of these means, and the standard deviations

TABLE 1

Average Weights—College Men—All Ages

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES Number	CASES Per cent
49	70	.....	....	1	.004
53	112.50 ± 3.71	7.78 ± 2.62	6.92	2	.01
54	110.00	.....	....	1	.004
55	113.00 ± 4.07	13.51 ± 2.88	10.16	5	.02
56	128.75 ± 3.17	13.30 ± 2.24	10.33	8	.03
57	110.00 ± 4.27	19.99 ± 3.01	18.17	10	.04
58	122.94 ± 2.86	17.51 ± 2.03	14.24	17	.07
59	120.33 ± 3.73	21.42 ± 2.64	17.80	15	.06
60	128.50 ± 3.14	29.44 ± 2.22	22.91	40	.17
61	123.36 ± 1.62	19.69 ± 1.15	15.96	67	.29
62	117.70 ± .82	14.87 ± .58	12.64	150	.65
63	121.56 ± .55	14.09 ± .39	11.59	298	1.29
64	124.87 ± .37	14.32 ± .26	11.47	678	2.93
65	128.20 ± .27	14.06 ± .19	10.97	1201	5.19
66	132.11 ± .21	14.12 ± .15	10.69	2055	8.89
67	135.63 ± .19	14.77 ± .14	10.89	2722	11.77
68	139.29 ± .17	15.30 ± .12	10.98	3535	15.29
69	142.43 ± .18	15.76 ± .13	11.07	3487	15.08
70	146.03 ± .19	15.78 ± .13	10.81	3215	13.90
71	149.66 ± .21	15.27 ± .15	10.20	2437	10.54
72	152.97 ± .29	16.89 ± .20	11.04	1582	6.84
73	157.71 ± .40	17.86 ± .29	11.32	892	3.86
74	162.19 ± .61	18.49 ± .43	11.40	420	1.82
75	164.62 ± .99	19.94 ± .70	12.11	183	.79
76	170.09 ± 1.65	18.67 ± 1.17	10.98	58	.25
77	168.26 ± 2.77	19.69 ± 1.96	11.70	23	.10
78	169.17 ± 3.16	16.21 ± 2.23	9.58	12	.05
79	152.50 ± 5.33	11.18 ± 3.77	7.33	2	.01
80	173.33 ± 15.13	38.84 ± 10.69	22.41	3	.01
81	197.50 ± 11.80	24.75 ± 8.35	12.53	2	.01
82	160.00	.....	....	1	.004
Mean Ht. 68.68 ± .01	141.65 ± .08	18.11 ± .06	12.79	23122	....

and coefficients of variability of individual cases from these means. Tables 2 to 7, inclusive, present similar data for each age group separately. Table 8 is a summary table giving for each age group the means of height and of weight, the standard deviations from these means and coefficients of correlation between height and weight.

Age

Since the numbers of students below 16 years and over 21 years of age were small, the tabulations were limited to the ages 16 to 21 years, inclusive. The greatest number of cases, 7368, was in the 18 year old group, and the smallest number, 610, in the 16 year old group (Table 8). The medico-actuarial tables for males were based upon 359 individuals 16 years of age; 732, 17 years; 1581, 18 years; 2416, 19 years; 3667, 20 years; and 6232, 21 years.

TABLE 2

Average Weights—College Men—Age 16

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES Number	CASES Per cent
56	135	.....	....	1	.16
57	80	.....	....	1	.16
59	93.33 ± 2.25	5.77 ± 1.59	6.18	3	.49
60	80	.....	....	1	.16
61	113.13 ± 1.79	7.53 ± 1.27	6.66	8	1.31
62	113.13 ± 1.97	11.67 ± 1.39	10.32	16	2.62
63	118.81 ± 1.82	12.34 ± 1.28	10.39	21	3.44
64	123.75 ± 2.08	18.46 ± 1.47	14.92	36	5.90
65	125.95 ± 1.18	13.54 ± .80	10.75	63	10.33
66	127.95 ± 1.14	13.60 ± .80	10.63	66	10.82
67	131.64 ± 1.17	14.76 ± .82	11.21	73	11.97
68	133.22 ± 1.02	14.10 ± .72	10.58	87	14.26
69	141.45 ± 1.19	16.01 ± .84	11.32	83	13.61
70	143.22 ± 1.32	17.07 ± .93	11.92	76	12.46
71	144.86 ± 1.45	12.94 ± 1.03	8.93	36	5.90
72	152.62 ± 2.38	16.17 ± 1.68	10.59	21	3.44
73	140.00 ± 6.21	24.32 ± 4.38	17.37	7	1.15
74	169.00 ± 3.32	13.92 ± 2.35	8.24	8	1.31
75	142.50 ± 2.39	3.54 ± 1.19	2.48	2	.32
78	150	.....	....	1	.16
Mean Ht. 67.48 ± .08	133.70 ± .49	18.11 ± .35	13.55	610	....

Height

The scattergrams for height and weight and the linear regression lines[2] for height according to weight are shown for all ages and for each age separately in figures 1 to 7 inclusive. Since the linear regression line shows a theoretical mean height for each weight group, the actual mean height for each weight has not been plotted except in figure 8, which presents both the actual and the linear regression lines.

TABLE 3

Average Weights—College Men—Age 17

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES Number	CASES Per cent
55	125	.....	....	1	.03
56	145	.....	....	1	.03
57	110	.....	....	2	.06
58	113.75 ± 9.88	29.26 ± 6.98	25.72	4	.12
59	95	.....	....	1	.03
60	113.00 ± 6.35	21.10 ± 4.50	18.67	5	.15
61	117.19 ± 2.59	15.38 ± 1.83	13.12	16	.49
62	117.00 ± 1.61	12.88 ± 1.12	11.01	30	.92
63	121.16 ± 1.61	17.80 ± 1.13	14.69	56	1.73
64	121.13 ± .91	14.26 ± .65	11.77	111	3.42
65	126.32 ± .67	13.58 ± .47	10.75	190	5.86
66	129.67 ± .52	14.08 ± .37	10.86	329	10.14
67	133.14 ± .48	14.76 ± .34	11.09	430	13.26
68	136.61 ± .43	14.17 ± .31	10.37	488	15.04
69	141.32 ± .51	16.95 ± .36	11.99	496	15.29
70	142.04 ± .53	15.78 ± .38	11.11	401	12.36
71	148.10 ± .56	14.38 ± .39	9.71	305	9.40
72	150.40 ± .81	16.53 ± .57	10.99	189	5.83
73	155.70 ± 1.11	16.39 ± .78	10.53	100	3.08
74	160.59 ± 1.53	17.44 ± 1.08	10.86	59	1.82
75	159.12 ± 2.13	13.02 ± 1.51	8.18	17	.52
76	158.57 ± 3.58	14.06 ± 2.53	8.87	7	.22
77	153.33 ± 4.06	10.41 ± 2.87	6.79	3	.09
78	150	.....	....	1	.03
79	155	.....	....	1	.03
82	160	.....	....	1	.03
Mean Ht. 68.39 ± .03	138.16 ± .21	17.83 ± .15	12.91	3244	....

[2] For formula, see (4) Application of statistical methods in physiology, Halbert L. Dunn. *Physiological Reviews*: 9: pages 275-398, April 1929.

For many purposes, particularly when the numbers of cases are small, such theoretical means are more satisfactory than the computed means. Any of these theoretical values, which are points on these regression lines, may be very easily obtained by completing the equations given in Table 9.

Frequency distribution curves of height for the entire group, and for the 16 and 21 year old groups separately are shown in Figure 9. The curve for the 16 year old group is significantly different from the curve for all ages combined but the curve for the 21 year old group

TABLE 4

Average Weights—College Men—Age 18

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES	
				Number	Per cent
49	70	.....	....	1	.01
53	112.50	.....	....	2	.03
54	110	.....	....	1	.01
55	130.00 ± 4.21	10.80 ± 2.97	8.31	3	.04
56	120	.....	....	2	.03
57	125.00 ± 1.59	4.08 ± 1.12	3.26	3	.04
58	130	.....	....	1	.01
59	130.00 ± 3.37	12.25 ± 2.39	9.42	6	.08
60	132.14 ± 5.34	20.99 ± 3.78	15.88	7	.10
61	129.54 ± 5.81	28.59 ± 4.11	22.07	11	.15
62	119.25 ± 1.97	18.49 ± 1.39	15.50	40	.54
63	121.48 ± .93	13.74 ± .65	11.31	101	1.37
64	124.19 ± .67	14.24 ± .48	11.47	204	2.77
65	126.62 ± .45	13.00 ± .32	10.27	382	5.18
66	132.08 ± .37	14.09 ± .26	10.61	656	8.90
67	135.31 ± .35	15.08 ± .25	11.14	861	11.69
68	138.25 ± .30	14.73 ± .21	10.65	1080	14.66
69	140.96 ± .30	15.31 ± .22	10.86	1143	15.51
70	145.82 ± .33	15.70 ± .23	10.77	1043	14.16
71	148.95 ± .36	14.91 ± .25	10.01	798	10.83
72	151.54 ± .51	17.29 ± .36	11.41	528	7.17
73	156.62 ± .72	17.97 ± .51	11.47	281	3.81
74	162.92 ± 1.11	18.86 ± .78	11.58	132	1.79
75	166.96 ± 2.08	23.04 ± 1.47	17.83	56	.76
76	171.94 ± 3.41	21.43 ± 2.41	12.46	18	.24
77	175.83 ± 2.21	8.01 ± 1.56	4.55	6	.08
78	185	.....	....	1	.01
80	130	.....	....	1	.01
Mean Ht. 68.72 ± .02	141.09 ± .14	18.08 ± .10	12.81	7368	....

almost coincides with the curve for the group as a whole. Curves for other ages which would fall between these extremes (see tables 1 to 7) have been omitted from the chart to avoid confusion. The range in height of these 23,122 male college students is from 49 inches to 82 inches with a mean height of 68.68 ± .01 inches. The standard deviation of height is 2.68 ± .01 inches and the coefficient of variability, 3.09 ± .01 per cent.

Table 10, which gives the mean height according to age of several large groups of American men, shows that the stature of these students is distinctly greater than the stature of other males of the same age for whom data are available. At 17 years of age the college students are an

TABLE 5

Average Weights—College Men—Age 19

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES	
				Number	Per cent
55	150	.....	....	1	.02
56	125.00 ± 5.74	14.71 ± 4.05	11.77	3	.05
57	106.25 ± 6.46	19.16 ± 4.57	18.03	4	.06
58	126.00 ± 4.41	14.63 ± 3.12	11.61	5	.08
59	117.50	.....	....	2	.03
60	129.50 ± 4.74	24.35 ± 3.35	18.79	12	.19
61	129.54 ± 5.25	25.83 ± 3.71	19.94	11	.17
62	115.62 ± 2.01	14.62 ± 1.42	12.64	24	.38
63	121.47 ± 1.27	14.07 ± .90	11.59	56	.89
64	126.35 ± .67	12.77 ± .47	10.11	166	2.63
65	129.41 ± .60	15.30 ± .42	11.82	296	4.69
66	132.52 ± .41	13.90 ± .29	10.49	534	8.46
67	131.56 ± .35	14.00 ± .25	10.27	727	11.52
68	139.69 ± .31	14.69 ± .22	10.52	1004	15.91
69	142.67 ± .35	15.92 ± .24	11.16	962	15.24
70	145.92 ± .34	15.26 ± .24	10.46	911	14.44
71	149.88 ± .41	14.83 ± .29	10.56	674	10.68
72	153.64 ± .50	15.87 ± .36	10.33	451	7.15
73	157.39 ± .71	16.95 ± .50	10.77	262	4.15
74	161.38 ± 1.05	17.31 ± .74	10.73	123	1.95
75	159.70 ± 1.84	19.27 ± 1.30	12.07	50	.79
76	173.57 ± 3.63	20.13 ± 2.57	11.60	14	.22
77	168.18 ± 3.86	19.01 ± 2.73	11.30	11	.17
78	173.33 ± 3.86	14.02 ± 2.73	8.09	1	.02
79	150	.....	....	1	.02
80	185	.....	....	1	.02
Mean Ht. 68.82 ± .02	142.45 ± .15	17.61 ± .11	12.36	6311	....

inch taller than the young men in citizens military training camps (5) and more than two inches taller than the applicants for life insurance(2). At 21 years, students are 0.6 of an inch taller than the men in citizens military training camps, an inch and a quarter taller than the life insurance group and almost an inch and a half taller than the army recruits(6). At other ages also the college students are taller than the other groups but the tendency is for the difference in height to decrease as age increases.

In considering these differences, the fact that the groups were measured as many as 20 to 25 years apart must be taken into consideration for various writers (Newcomer(7), Mosher(8), Jackson(9), Sargent(10), and MacKinnon and Jackson(11)) have shown that over a

TABLE 6

Average Weights—College Men—Age 20

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES Number	CASES Per cent
56	135	.....	....	1	.03
58	150	.....	....	2	.06
59	137.50	.....	....	2	.06
60	126.11 ± 5.08	22.61 ± 3.59	17.93	9	.25
61	125.00 ± 2.69	14.94 ± 1.90	11.95	14	.39
62	121.09 ± 1.76	12.52 ± 1.25	10.34	23	.64
63	122.16 ± 1.39	12.39 ± .97	10.14	37	1.02
64	127.97 ± 1.93	14.14 ± .65	11.05	106	2.93
65	131.68 ± .71	14.08 ± .50	10.69	179	4.95
66	133.51 ± .54	13.94 ± .38	10.44	306	8.47
67	136.97 ± .49	14.87 ± .34	10.86	423	11.71
68	142.15 ± .48	16.76 ± .34	11.79	551	15.25
69	144.61 ± .44	14.89 ± .31	10.30	526	14.56
70	147.86 ± .49	15.92 ± .35	10.77	478	13.23
71	150.96 ± .49	14.75 ± .35	9.77	408	11.29
72	154.39 ± .66	15.88 ± .47	10.28	261	7.22
73	159.55 ± .98	18.80 ± .70	11.78	166	4.59
74	163.11 ± 1.43	16.55 ± 1.01	10.15	61	1.69
75	169.88 ± 2.01	19.05 ± 1.42	11.21	41	1.13
76	168.33 ± 3.56	18.26 ± 2.51	10.85	12	.33
77	168.33	.....	....	3	.08
78	165	.....	....	1	.03
80	205	.....	....	1	.03
81	197.50	.....	....	2	.06
Mean Ht. 68.79 ± .03	144.05 ± .20	18.10 ± .14	12.56	3613	....

period of years there has been a tendency for the height of college students to increase. However, since the maximum increase over a period of forty years was one inch, this alone cannot account for the differences observed. Jackson(3) in 1927 pointed out that students of the University of Minnesota were distinctly taller than the general population from which they came and that German and Norwegian university students also seemed to be taller than the average of the young men of the same age drafted for military service in their respective countries.

The greater relative height of the younger college students indicates that in earlier years their growth has been accelerated beyond that of the average population. At 21 years of age either this acceleration is still affecting the relative height of the college group or their greater height is due to an inherent tendency to greater stature. Maximum stature is attained by this college group at 19 years of age although between 18 and 19 years the average growth was only .1 of an inch. This difference, although small, is more than three times the probable

TABLE 7

Average Weights—College Men—Age 21

HEIGHT	MEAN WEIGHT	S. D.	C. V.	CASES	
				Number	Per cent
58	116.00 ± 4.70	15.62 ± 3.33	13.67	5	.25
59	140	.....	....	1	.05
60	146.67 ± 13.27	48.19 ± 9.38	32.86	6	.30
61	126.43	.....	....	7	.35
62	117.94 ± 2.35	14.37 ± 1.66	12.18	17	.86
63	124.64 ± 1.82	14.26 ± 1.29	11.44	28	1.42
64	125.27 ± 1.33	14.50 ± .93	11.57	55	2.78
65	129.51 ± .96	13.55 ± .68	10.46	91	4.61
66	135.49 ± .76	14.37 ± .54	10.61	164	8.30
67	138.80 ± .60	12.93 ± .43	9.32	208	10.53
68	141.71 ± .54	14.44 ± .38	10.19	325	16.45
69	145.72 ± .62	15.28 ± .44	10.49	279	14.12
70	150.16 ± .59	15.33 ± .42	10.21	305	15.44
71	152.15 ± .73	15.86 ± .51	10.42	216	10.93
72	156.92 ± 1.15	19.44 ± .81	12.39	130	6.58
73	163.03 ± 1.32	16.90 ± .92	10.37	76	3.85
74	162.97 ± 2.55	22.95 ± 1.80	14.08	37	1.87
75	166.76 ± 2.11	12.86 ± 1.49	7.71	17	.86
76	172.86 ± 4.18	16.41 ± 2.96	12.98	7	.35
78	170	.....	....	2	.10
Mean Ht. 68.77 ± .04	144.87 ± .28	18.48 ± .20	12.76	1976	....

TABLE 8

Summary Table—Male Students of All Colleges

AGE	MEAN		STANDARD DEVIATION		PARTIAL STANDARD DEVIATION		$r_{w.h.}$	NO. CASES
	Height	Weight	Height	Weight	Of height with weight held constant	Of weight with height held constant		
16	67.48 ± .08	133.70 ± .49	2.89 ± .06	18.11 ± .35	2.43 ± .05	15.23 ± .05	+ .5408 ± .0193	610
17	68.39 ± .03	138.16 ± .21	2.71 ± .02	17.83 ± .15	2.32 ± .02	15.29 ± .02	+ .5140 ± .0087	3244
18	68.72 ± .02	141.09 ± .14	2.64 ± .01	18.08 ± .10	2.29 ± .01	15.67 ± .01	+ .4985 ± .0059	7368
19	68.82 ± .02	142.45 ± .15	2.62 ± .02	17.61 ± .11	2.28 ± .01	15.35 ± .01	+ .4899 ± .0065	6311
20	68.79 ± .03	144.05 ± .20	2.71 ± .02	18.10 ± .14	2.34 ± .02	15.64 ± .02	+ .5037 ± .0084	3613
21	68.77 ± .04	144.87 ± .28	2.56 ± .03	18.48 ± .20	2.22 ± .02	16.06 ± .02	+ .4947 ± .0115	1976
All ages	68.68 ± .01	141.65 ± .08	2.68 ± .01	18.11 ± .06	2.31 ± .01	15.26 ± .01	+ .5056 ± .0033	23122

TABLE 9

Determination of Points on Regression Lines *

AGE	HEIGHT	WEIGHT
16	$\overline{\text{Ht.}} = .0863$ wt. $+ 55.94$	$\overline{\text{Wt.}} = 3.3889$ ht. $- 94.98$
17	$= .0781$ wt. $+ 57.60$	$= 3.3812$ ht. $- 93.12$
18	$= .0728$ wt. $+ 58.45$	$= 3.4140$ ht. $- 93.52$
19	$= .0729$ wt. $+ 58.44$	$= 3.2928$ ht. $- 84.16$
20	$= .0754$ wt. $+ 57.93$	$= 3.3642$ ht. $- 87.37$
21	$= .0685$ wt. $+ 58.84$	$= 3.5372$ ht. $- 98.38$
All ages	$= .0748$ wt. $+ 58.08$	$= 3.4166$ ht. $- 93.00$

* By filling in these partially completed formulae any point on the regression lines for height or for weight may be determined. The equations upon which these formulae are based are:

$$\overline{\text{Wt.}} - \text{mean wt.} = r_{\text{wt.ht.}} \frac{\sigma_{\text{wt.}}}{\sigma_{\text{ht.}}} (\text{ht.} - \text{mean ht.}) \text{ and}$$

$$\overline{\text{Ht.}} - \text{mean ht.} = r_{\text{wt.ht.}} \frac{\sigma_{\text{ht.}}}{\sigma_{\text{wt.}}} (\text{wt.} - \text{mean wt.})$$

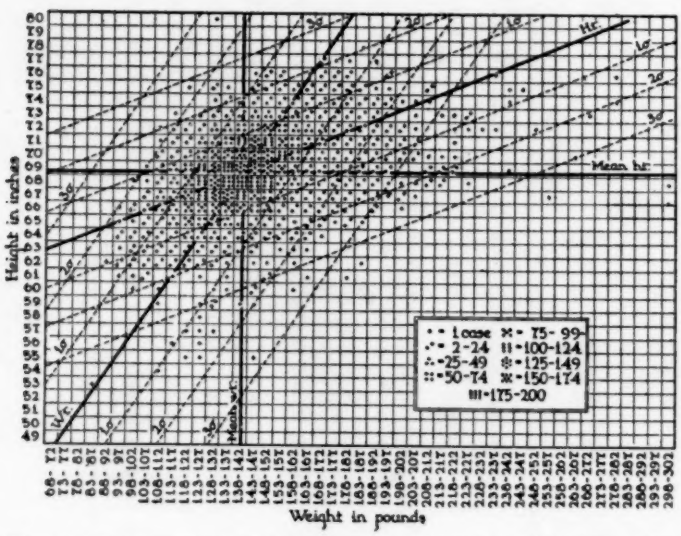

FIG. 1. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 16 TO 21 YEARS OF AGE

error of the difference and so very probably represents a significant growth in height during this period. From these data it is evident that these college men have attained full growth in stature several years earlier than full stature is attained by most men in the population.

Although various factors doubtless contribute to the acceleration of growth and the greater height of college and university students, probably the greatest contributing factor is that in childhood they have had care, food and living conditions above the average. Although in general students, particularly of state and municipal universities, represent a fairly good cross-section of population, they doubtless come from homes in which the parents show more than average interest in the welfare of the children and have more than average resources with which to provide them opportunities for growth and development.

The possibility of a greater fundamental stature among college men raises the question of a relationship between physical and mental growth. Johnson(12), Heidbreider(13) and others find no significant correlation

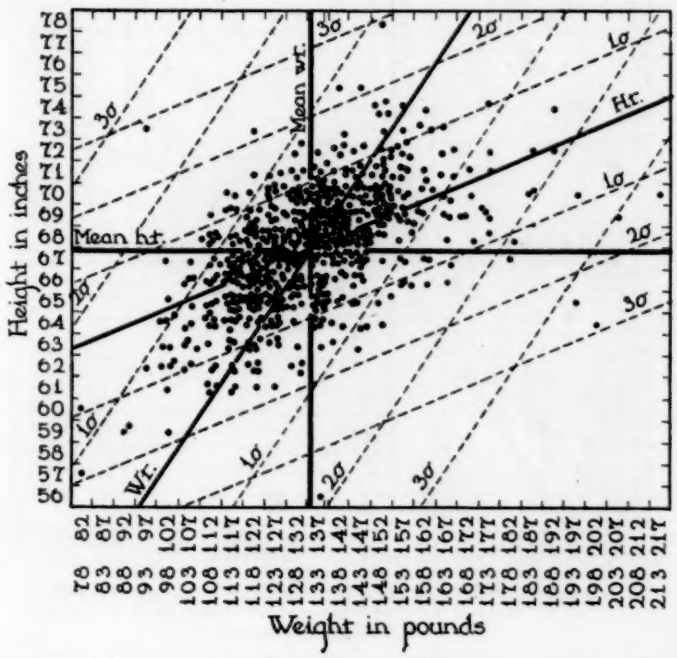

FIG. 2. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 16 YEARS OF AGE

between stature and intelligence in the groups which they studied. Paterson(14) in making a comprehensive analysis of the data published on this subject finds evidence of very slight if any correlation of height and weight with intelligence in normal individuals. On the other hand, Porter(15), Doll(16), Baldwin(17), Davenport and Minogue(18), and others report significant correlations between physical and mental growth. If this latter opinion be true, the greater height of these students may be just one part of a general acceleration in growth which makes them a select group, both mentally and physically. This factor, however, if existent is doubtless of much less importance than are the social and economic factors.

Variability of Height with Age

The standard deviation for height varies from 2.89 ± .06 inches in the 16 year old group to 2.56 ± .03 inches in the 21 year old group

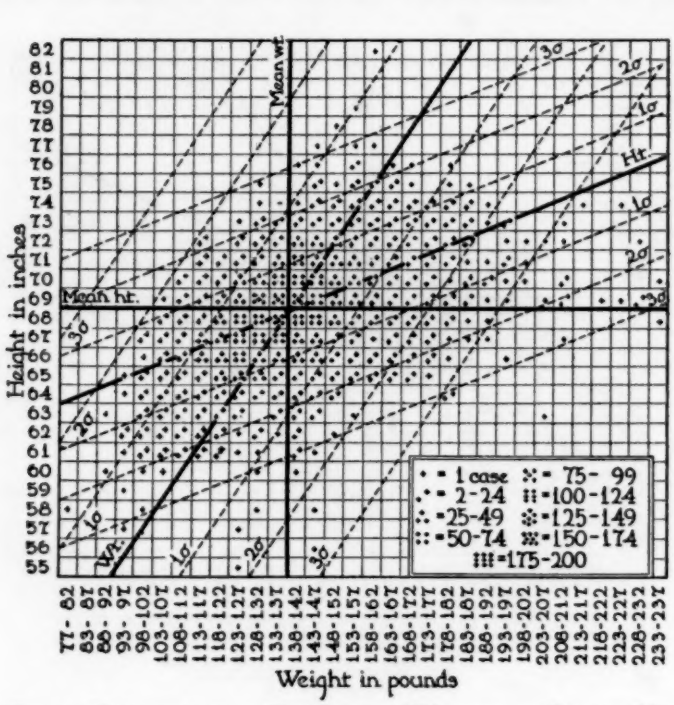

FIG. 3. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 17 YEARS OF AGE

(Table 8). With weight held constant in the calculations by means of a statistical formula(4) the standard deviation for height varies from 2.43 ± .05 inches in the 16 year old group to 2.22 ± .02 inches in the 21 year old group. Since in each age group there is some correlation but not perfect correlation between height and weight, the standard deviation for either height or weight is somewhat lower when the other is held constant. As would be expected, the variability in height as measured by the standard deviation is greatest during the period of most active growth, that is, in the younger age groups.

Weight

Curves showing the frequency distributions for weight of the entire group and of the 16 and 21 year old groups are shown in figure 10. The curves of all three groups show approximately normal distributions for weight. The differences in the curves are due to the increase in weight which occurs with age. Similar distribution curves for other

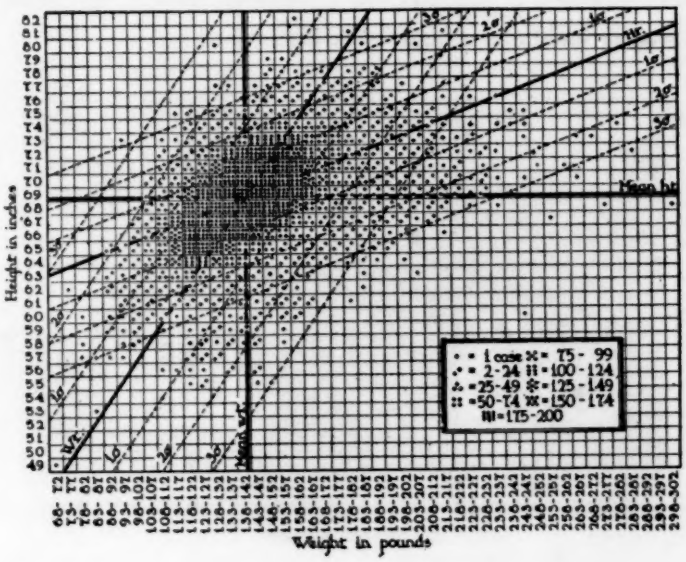

FIG. 4. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 18 YEARS OF AGE

age groups, which could be plotted from the data shown in tables 2 to 7, would correspond in shape to the ones presented and would fall between the curves of the 16 and 21 year old groups. The range of weight for the groups as a whole is from 68 pounds to 298 pounds; the mean weight, $141.65 \pm .08$ pounds, the standard deviation of weight, $18.11 \pm .06$ pounds and the coefficient of variability, $12.78 \pm .07$ per cent.

A comparison of the mean weights of these college men with the mean weights of other groups of the same age is given in Table 11. From this table it is apparent that at these ages American college students exceed in weight each of these other groups analyzed. The differences in weight are most marked at the younger ages and decrease progressively with age but even at 21 years college men are heavier as well as taller than any of these other groups.

Although the college men are taller and heavier at each age, a study of body build (Table 12) shows that after 16 years of age they are relatively slighter than any of the other groups except the young men in citizens military training camps. In making this comparison of body build, Davenport's index, $\frac{\text{weight}}{\text{height}^2} \times 1000$, has been used, a low index indicating slender build and a high index stocky build.

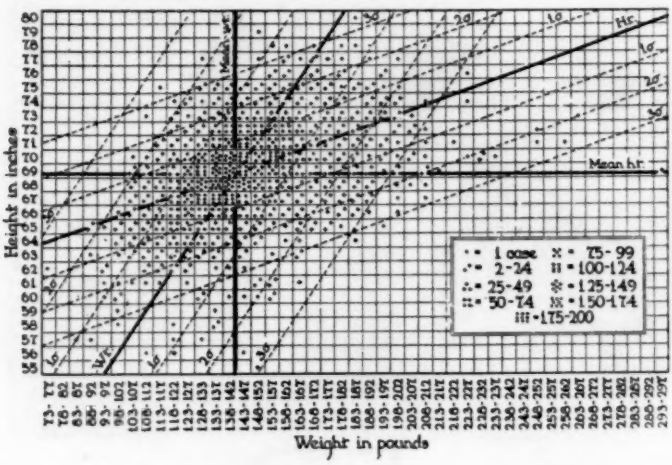

FIG. 5. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 19 YEARS OF AGE

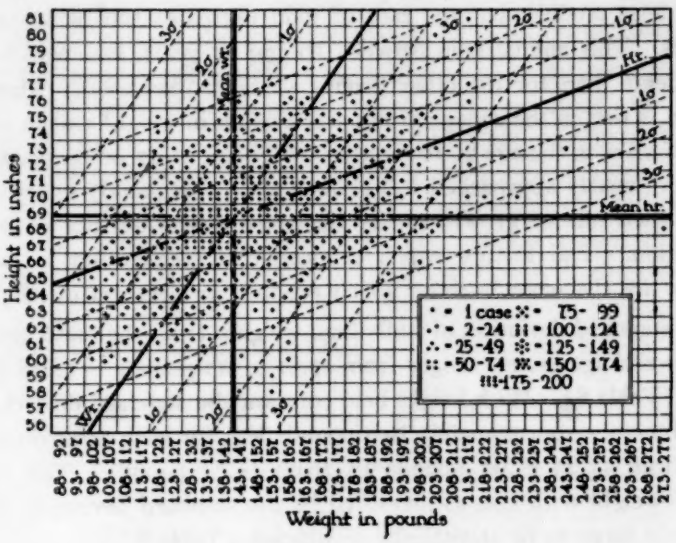

FIG. 6. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 20 YEARS OF AGE

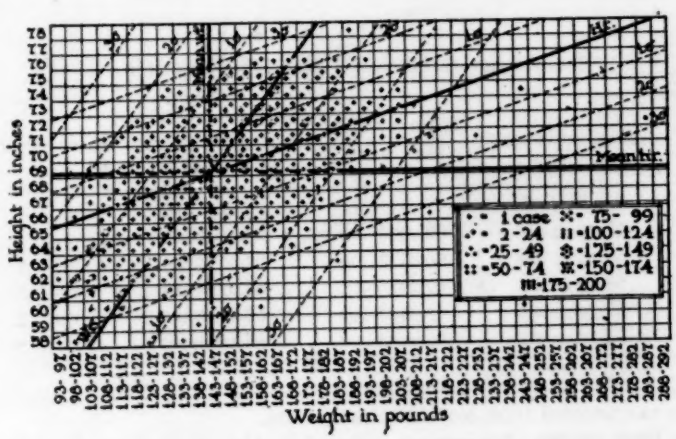

FIG. 7. SCATTERGRAM OF HEIGHTS AND WEIGHTS OF COLLEGE MEN 21 YEARS OF AGE

These college students show a progressive gain in weight each year for the ages studied, but the rate of gain decreases somewhat as age increases. This annual gain between 16 and 21 years, however, is less for students than for the other groups studied. Apparently what has occurred is that in the college group acceleration in weight and in height occurred prior to the age of 16; so that by the age of 17 or 18 years they have more nearly approached full growth and consequently experienced a diminished rate of growth earlier than others who did not show this acceleration. The factors which produce this acceleration in weight probably are the same as those which produce acceleration in height.

The standard deviation of individual weights from the mean weights of the several age groups ranges from 17.61 ± .11 pounds to 18.48 ± .20 pounds (Table 8). With height held constant the standard deviation of weight becomes approximately two pounds less for each age group and varies from 15.23 ± .05 pounds to 16.06 ± .02 pounds. The variability of weight with age, as measured by the standard deviation, is not sufficiently large to be statistically significant (Table 8).

Tables 2 to 7 show the statistical constants for weight computed for each inch in height of each age group. From such means as these the various so-called standard tables of weight for age and height have been

TABLE 10

Comparative Heights of Young American Men

AGE	COLLEGE STUDENTS	MEDICO-ACTUARIAL DATA *	MEN IN CITIZENS MILITARY TRAINING CAMPS †	ARMY RECRUITS ‡
16	67.48 ± .08	65.00 ± .11	66.92 ± .03	.....
17	68.39 ± .03	66.23 ± .06	67.40 ± .01	.....
18	68.72 ± .02	66.81 ± .04	67.79 ± .01	66.90 ± .01
19	68.82 ± .02	67.23 ± .03	68.07 ± .01	66.97 ± .01
20	68.79 ± .03	67.34 ± .03	68.10 ± .02	67.02 ± .02
21	68.77 ± .04	67.50 ± .02	68.16 ± .02	67.33 ± .01

* Corrected for height without shoes by subtracting 0.9 inch from mean heights with shoes as computed from medico-actuarial data.

† Data from 100,000 examinations collected by Col. A. G. Love, U. S. A. and used by Berkson (4).

‡ Army recruits accepted for military service 1906-1915, data analyzed and published by Hoffman (5).

prepared. In the groups in which the number of cases is sufficiently large to give dependable results the probable errors of these means are small. For them the standard deviations range from about 14 to 16 pounds and the coefficients of variability from 10 per cent to 12 per cent. These coefficients of variability correspond very closely to the percentages above or below average weight which are usually accepted as the range of normal variability. Whether the frequent adoption of 10 per cent as normal variability for weight was made on statistical or biological grounds or was merely arbitrary does not appear from the published reports; but from our data it does not seem that one is justified in considering all weights which vary more than 10 per cent from the means as necessarily abnormal. The reason for this is that in any

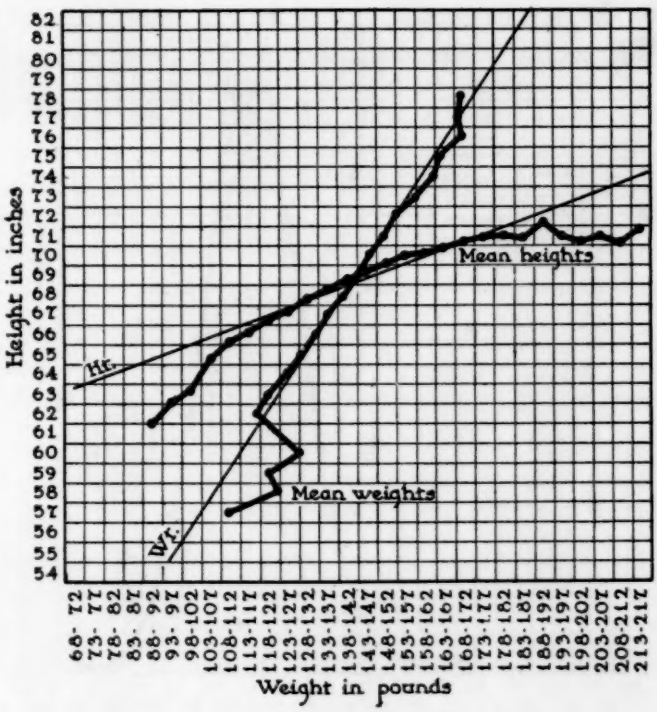

FIG. 8. ACTUAL AND LINEAR REGRESSION LINES OF HEIGHT AND OF WEIGHT FOR AGES 16 TO 21 YEARS

normal distribution 31.74 per cent of the cases will fall more than one standard deviation or coefficient of variability above or below the mean. In other words, in a normal distribution for weight approximately one-third of the cases will be more than 10 per cent above or below the average; and clearly in an unselected group of persons it is not reasonable to assume that one-third of the group is abnormal in weight, or in anything else for that matter. Two standard deviations, or coefficients of variability, from the mean in a normal distribution will include 95.45 per cent and three standard deviations, 99.73 per cent of the cases. In the scattergrams for height and weight according to age, figures 1 to 7, lines showing the areas and cases included in one, two, and three standard deviations from the mean are shown in order that the number of

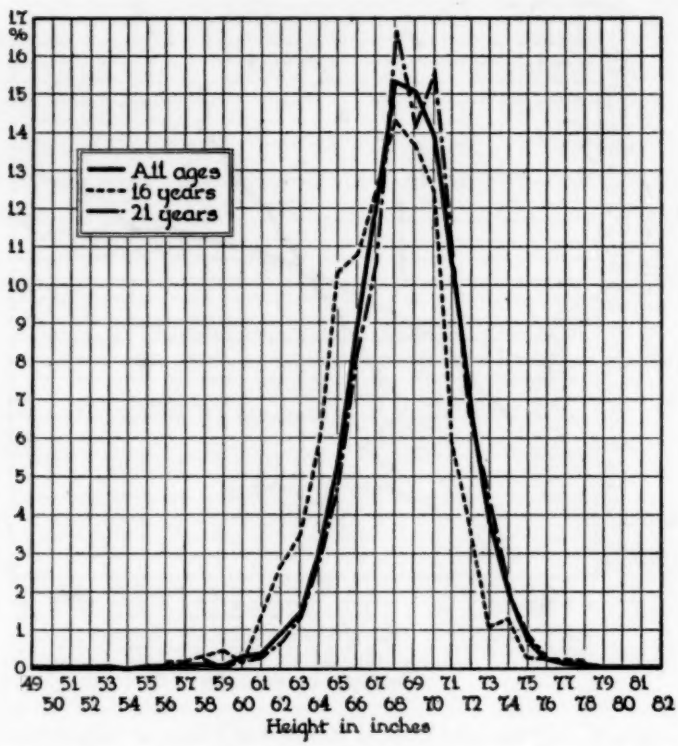

FIG. 9. FREQUENCY DISTRIBUTION OF HEIGHTS OF COLLEGE MEN

individuals whose height, weight or both fall outside of these limits may be observed. In view of the large number of cases which fall outside of one standard deviation in height and in weight it would seem that further studies such as those of Love(19), the Medico-Actuarial Society(20), and others should be made to determine, if possible, the best weight for each age and height, and the variability from this optimum which should be considered as normal.

Correlations Between Height and Weight

The coefficients of correlation (r) between height and weight are shown for the various age groups and for all ages taken together in Table 8 and the regression lines for height and weight are shown in figures 1 to 7. The highest degree of correlation in any of the age groups, $+.54 \pm .02$, occurs at 16 years. For the ages 17 to 21 years inclusive the coefficients of correlation are slightly smaller than this but not significantly so. Berkson(5) in a very comprehensive study of Growth Changes in Physical Correlations finds periods of maximum correlation between height and weight at 1.5 years, 6 years, and 14 years and periods of minimum correlation at 3 years, 11 years, and 21 years. According to

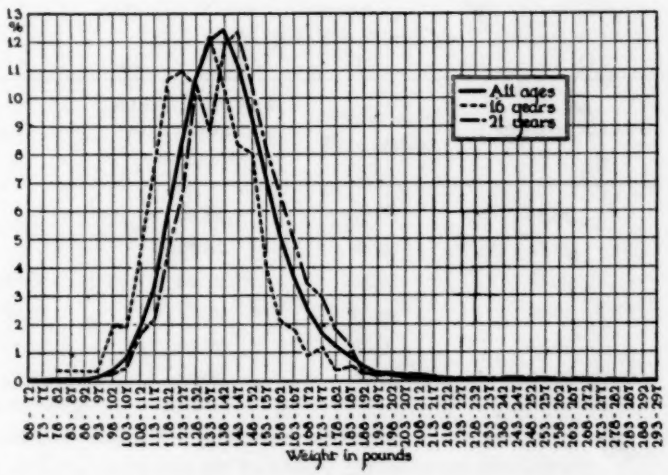

FIG. 10. FREQUENCY DISTRIBUTION OF WEIGHTS OF COLLEGE MEN

Berkson's curve this college group, ranging from 16 to 21 years of age, should fall in the period of diminishing correlation and Table 8 shows this to be true. The curve of our correlations between the heights and the weights of these college students of various ages lies parallel to the

TABLE 11

Comparative Weights of Young American Men

AGE	COLLEGE STUDENTS	MEDICO-ACTUARIAL DATA *	MEN IN CITIZENS MILITARY TRAINING CAMPS	ARMY RECRUITS 1906-1915
16	133.70 ± .49	121.71 ± .51	128.09 ± .19	.....
17	138.16 ± .21	129.91 ± .27	130.79 ± .07	.....
18	141.09 ± .14	135.62 ± .17	134.39 ± .07	134.97 ± .06
19	142.45 ± .15	139.44 ± .13	137.71 ± .09	136.26 ± .08
20	144.05 ± .20	139.77 ± .10	139.85 ± .11	138.13 ± .10
21	144.87 ± .28	141.53 ± .07	140.87 ± .15	141.17 ± .03

* Corrected for weight without shoes or clothing by subtracting 4.46 pounds from the mean weights with clothing as computed from medico-actuarial data.

TABLE 12

Body Build of Young Men *

AGE	COLLEGE STUDENTS	MEDICO-ACTUARIAL DATA	MEN IN CITIZENS MILITARY TRAINING CAMPS	ARMY RECRUITS
16	29.36	28.81	28.60	....
17	29.54	29.62	28.79	....
18	29.88	30.38	29.24	30.16
19	30.08	30.85	29.72	30.38
20	30.44	30.82	30.16	30.75
21	30.63	31.06	30.32	31.14

* These indices of body build have been calculated according to Davenport's formula: $\frac{\text{wt.}}{\text{ht.}^3} \times 1000$, and represent the indices of the groups as a whole and are not the means of the indices of the individuals in the groups.

TABLE 13

Smoothed Average Weight—College Men
(Medico-actuarial weights in parenthesis)

HEIGHT	AGE					
	16	17	18	19	20	21
4 feet- 8 inches	94	96	98	100	101	102
4 " - 9 "	97	100	101	104	105	106
4 " -10 "	100	103	104	107	108	109
4 " -11 "	104	106	108	110	111	112
5 " - 0 "	107 (109)	110 (111)	112 (113)	113 (115)	114 (117)	115 (118)
5 " - 1 "	111 (111)	113 (113)	115 (115)	117 (117)	118 (119)	119 (120)
5 " - 2 "	114 (114)	116 (116)	118 (118)	120 (120)	121 (122)	122 (123)
5 " - 3 "	117 (117)	119 (119)	121 (121)	123 (123)	125 (125)	126 (126)
5 " - 4 "	121 (120)	123 (122)	125 (124)	127 (126)	128 (128)	129 (130)
5 " - 5 "	124 (124)	126 (126)	128 (128)	130 (130)	131 (132)	132 (134)
5 " - 6 "	128 (128)	130 (130)	132 (132)	133 (134)	135 (136)	136 (138)
5 " - 7 "	131 (132)	133 (134)	135 (136)	136 (138)	138 (140)	139 (141)
5 " - 8 "	134 (136)	137 (138)	139 (140)	140 (142)	141 (144)	142 (145)
5 " - 9 "	138 (140)	140 (142)	142 (144)	143 (146)	145 (148)	146 (149)
5 " -10 "	141 (144)	144 (146)	145 (148)	146 (150)	148 (152)	149 (153)
5 " -11 "	145 (149)	147 (151)	149 (153)	150 (155)	151 (156)	153 (157)
6 " - 0 "	148 (154)	150 (156)	152 (158)	153 (160)	155 (161)	156 (162)
6 " - 1 "	151 (159)	154 (161)	156 (163)	157 (165)	158 (166)	160 (167)
6 " - 2 "	155 (164)	157 (166)	159 (168)	160 (170)	162 (171)	164 (172)
6 " - 3 "	158 (169)	161 (171)	163 (173)	164 (175)	165 (176)	167 (177)
6 " - 4 "	162 (174)	164 (176)	166 (178)	167 (180)	168 (181)	171 (182)
6 " - 5 "	165 (179)	167 (181)	169 (183)	170 (185)	172 (186)	174 (187)

composite curve which Berkson draws but is uniformly below it until 21 years of age, at which point Berkson's curve flattens out at the same level which has been reached earlier by the college students. The lower correlations for the college group are due in part to the fact that Berkson omitted from his tables individual cases which were extremely off from the trend of the mass of material but this difference in procedure does not account for the fact that the correlation coefficients for the college group reach a low point two years earlier than do those for his large mass of composite data.

Regression Lines for Height and Weight

The regression lines for height and for weight, as shown in figures 1 to 7, are the linear regression lines, the points on which have been calculated from the formulas shown in connection with Table 9. For all ages taken together a straight regression line is satisfactory for heights between 62 and 76 inches and is reasonably good for weights between 115 and 180 pounds. Beyond these limits, however, the regressions of height on weight and of weight on height become somewhat non-linear, with weight tending to increase independently of height. On these scattergrams the non-linear portions of the regression lines have not been plotted because this study is concerned only incidentally with the type of relationship between height and weight and because the number of cases falling in the areas in which the straight line is unsatisfactory is small. The partial standard deviations in figures 1 to 7 are accurate also only between the same limits. In Figure 8, however, the computed averages, or true regression lines, of weight for each inch in height and of height for each weight group are shown together with the linear regression lines which have been used throughout this study.

COMPARISON OF WEIGHTS OF COLLEGE MEN WITH WEIGHTS ON MEDICO-ACTUARIAL TABLE

The original purpose of this study was the preparation of age, height and weight tables for college students and the comparison of these with the tables most widely used as standards. Table 13 presents graded mean weights for each age and each inch in height of college men. The weights shown in the table are in most instances actual mean weights for the group but when the actual means were clearly out of line with the general trend theoretical means were used in their stead. These

theoretical means were computed by the use of the formulae for determining points on the regression lines for weight (Table 9). In addition to this smoothing process a few other adjustments were made by the three point smoothing method, or visually in the 16 and 21 year old groups, so as to have a properly graded relationship between age and weight. Table 13 shows in parenthesis the weights given in the medico-actuarial table. The differences between the groups are apparent. Some of these differences doubtless are due to the fact that the students were weighed and measured stripped while the heights and weights given in the medico-actuarial table include shoes and ordinary clothing. The errors thus introduced, however, are not so great as might be supposed because the wearing of shoes adds approximately an inch to the height and so puts the individual into the next higher group, thereby raising the standard for weight by an amount approximately equal to the average weight of shoes and clothing.

By weighing and measuring 1160 male students at the University of Minnesota both stripped and with shoes and ordinary clothing, it was found that the extra height due to shoes averaged 0.88 inches, and the weight of shoes and clothing averaged 4.46 pounds. According to the medico-actuarial tables the average increase in weight of median groups for each inch in height is five pounds; an amount which corresponds very closely to this average weight of shoes and clothing. However, the range of extra height due to shoes was from .25 of an inch to 1.75 inches and the standard deviation from the mean was $\pm$ .30 inches; while the range in weight of shoes and clothing was from 2 pounds to 10.5 pounds, and the standard deviation, $\pm$ 1.25 pounds. With so much variability in the height due to shoes and in the weight of shoes and clothing, it is evident that any correction would be grossly in error for many individual cases even though it might be very satisfactory for the group as a whole.

In addition to these differences, which tend to produce inaccuracies when the medico-actuarial tables are used as standards with which to compare stripped heights and weights, it has been shown that there are significant differences in height, weight, and body build between the college group and the applicants for life insurance from whose measurements the medico-actuarial tables were compiled. These differences are most marked in the younger and shorter groups and in the older and taller groups, the college students who are younger and shorter tending to be of a more stocky build and those who are older and taller tending

to be of a slighter build. Combined, these factors produce differences in certain parts of the table which are considerable (Table 13). For example, at 19 years of age and 6 feet tall there is a difference of 7 pounds, 4.5 per cent, in the mean weights of the groups; and at 20 years of age and 6 feet 4 inches tall there is a difference of 13 pounds, or 7.5 per cent. In other words, a student 19 years of age and 6 feet tall, who on the basis of these tables for college students would be considered of average weight, according to the medico-actuarial table would be 4.5 per cent underweight and a student 20 years of age and 6 feet 4 inches tall who would be average according to the college tables would be 7.5 per cent underweight according to the medico-actuarial tables. Since such differences might influence the advice given to certain individuals in regard to weight regulation, it would seem that for this purpose the use of the more suitable tables would be desirable.

On the other hand, these differences, although significant for the groups as a whole, are of distinctly less importance when individual cases are considered because of the large individual ranges, standard

TABLE 14

College of the City of New York

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	66.36±.11	131.76± .81	2.60±.08	18.64± .57	+.5279±.0313	241
17	66.90±.07	135.27± .53	2.58±.05	18.38± .37	+.5499±.0200	552
18	66.97±.07	138.47± .44	2.52±.05	16.84± .31	+.5231±.0189	669
19	67.23±.08	141.52± .55	2.56±.05	18.28± .39	+.4826±.0232	496
20	67.00±.13	142.43± .91	2.82±.09	20.46± .64	+.4945±.0336	230
21	67.04±.16	141.38±1.17	2.56±.11	18.63± .82	+.5037±.0468	116

TABLE 15

University of California Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	68.48±.27	129.52±1.45	2.27±.19	12.01±1.03	+.6537±.0693	31
17	68.80±.11	140.15± .85	2.45±.08	19.13± .60	+.5114±.0327	232
18	69.17±.08	142.65± .46	2.56±.05	18.31± .39	+.5080±.0222	508
19	68.90±.08	143.28± .53	2.75±.06	17.68± .37	+.4719±.0233	507
20	69.32±.08	144.24± .55	2.57±.06	16.51± .39	+.5067±.0246	416
21	69.10±.09	146.39± .61	2.46±.06	16.38± .43	+.4833±.0285	328

deviations, and coefficients of variability which occur. Furthermore, as shown in tables 14 to 23, the differences between the heights and weights of students of the various colleges are in many instances as great as the differences between the college table and the medico-actuarial standards. For these reasons, it would seem that for general use any of the tables are reasonably satisfactory provided that their limitations and the possibility of normal individual variations are considered.

TABLE 16

University of Cincinnati Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	66.80±.44	133.33±3.10	2.51±.31	17.80±2.19	+.4696±.1358	15
17	68.60±.14	135.65± .92	2.72±.10	17.79± .65	+.5938±.0336	169
18	68.54±.06	137.64± .44	2.38±.04	17.53± .31	+.4763±.0195	718
19	68.64±.07	139.79± .51	2.38±.05	17.95± .36	+.4925±.0216	559
20	68.41±.09	141.48± .68	2.68±.07	19.70± .48	+.4722±.0267	386
21	68.36±.13	140.61± .89	2.83±.09	20.10± .63	+.5727±.0298	231

TABLE 17

Cornell University Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	67.14±.30	135.27±2.53	2.72±.21	22.84±1.79	+.5927±.0720	37
17	67.90±.10	136.00± .64	2.68±.07	17.36± .46	+.5022±.0277	331
18	68.54±.06	139.81± .41	2.60±.04	17.46± .29	+.5572±.0161	833
19	68.83±.06	141.24± .40	2.48±.04	16.03± .29	+.5100±.0186	718
20	68.63±.10	142.67± .59	2.80±.07	16.68± .42	+.6422±.0209	359
21	68.36±.15	143.49±1.13	2.74±.10	21.14± .80	+.5542±.0371	159

TABLE 18

University of Minnesota Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	68.83±.41	137.50±2.25	2.94±.29	16.29±1.59	+.5171±.1011	24
17	68.41±.09	137.90± .64	2.36±.07	16.12± .45	+.4399±.0320	290
18	68.65±.05	141.22± .39	2.41±.04	17.29± .27	+.4993±.0169	903
19	68.55±.06	140.61± .40	2.39±.04	16.58± .28	+.5209±.0176	778
20	68.62±.06	142.89± .51	2.53±.05	17.06± .36	+.5063±.0220	518
21	68.65±.09	144.89± .66	2.52±.07	17.66± .47	+.5717±.0252	323

TABLE 19

Princeton University Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	68.56±.51	137.59±2.16	3.90±.36	16.66±1.53	+.4333±.1054	27
17	69.21±.10	139.07± .70	2.40±.07	17.49± .49	+.5024±.0298	287
18	69.30±.06	141.41± .37	2.42±.04	16.21± .26	+.4966±.0172	874
19	69.36±.06	141.69± .38	2.43±.04	16.18± .27	+.5474±.0163	842
20	69.26±.08	144.03± .60	2.39±.06	17.23± .42	+.5020±.0260	376
21	69.50±.16	146.31± .97	2.26±.11	13.47± .68	+.4973±.0541	88

TABLE 20

Stanford University Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	69.08±.23	139.70±1.40	2.39±.16	14.68± .99	+.6620±.0536	50
17	69.20±.09	142.38± .62	2.53±.06	18.37± .44	+.5231±.0245	401
18	69.20±.06	142.98± .45	2.45±.04	17.64± .32	+.5251±.0186	689
19	69.20±.09	144.16± .58	2.55±.06	17.31± .41	+.4825±.0257	407
20	69.25±.10	147.91± .77	2.46±.07	18.74± .54	+.4646±.0322	270
21	69.04±.13	147.56± .98	2.88±.10	20.92± .69	+.5838±.0309	207

TABLE 21

University of Texas Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	68.55±.15	135.79±1.02	2.68±.11	17.89± .72	+.5238±.0415	139
17	68.87±.08	138.68± .50	2.75±.06	17.54± .36	+.4933±.0218	550
18	69.08±.07	142.72± .54	2.69±.05	21.38± .38	+.4366±.0203	724
19	69.05±.08	143.18± .52	2.74±.06	18.35± .37	+.4103±.0236	563
	*69.09±.08	142.87± .50	2.65±.05	17.52± .35	+.4161±.0236	559
20	69.04±.10	144.85± .71	2.80±.07	19.23± .50	+.4964±.0277	338
21	68.85±.12	144.89± .78	2.75±.09	17.34± .55	+.4922±.0340	226

* Excluding 4 cases of 19 years of age whose height or weight was more than 3σ from the mean of the group.

TABLE 22

University of Wisconsin Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	68.20±.44	136.00±3.25	2.04±.31	15.24±2.30	+.5073±.1585	10
17	68.15±.15	138.88± .87	2.87±.11	16.25± .61	+.4766±.0412	160
18	68.25±.09	141.04± .51	3.08±.06	18.34± .36	+.4987±.0208	591
19	68.36±.08	143.93± .55	2.83±.06	19.57± .39	+.4774±.0217	576
20	68.25±.10	143.49± .62	2.75±.07	16.66± .44	+.4563±.0293	322
21	68.07±.12	143.88± .83	2.61±.08	18.07± .58	+.2487±.0429	218
	*68.25±.11	143.17± .74	2.31±.08	16.04± .52	+.4173±.0382	213

* Excluding 5 cases of 21 years of age whose height or weight was more than 3σ from the mean of the group.

TABLE 23

Yale University Men

AGE	MEAN		σ		$r_{wt.ht.}$	NO. CASES
	Height	Weight	Height	Weight		
16	66.44±.31	125.97±1.75	2.72±.22	15.58±1.24	+.6707±.0618	36
17	68.57±.11	138.11± .71	2.60±.08	17.30± .50	+.4995±.0307	272
18	69.27±.06	142.97± .43	2.56±.04	18.88± .31	+.4934±.0174	859
19	69.52±.06	145.40± .41	2.49±.04	18.05± .29	+.5372±.0163	865
20	69.60±.09	147.59± .65	2.62±.06	18.95± .46	+.5107±.0252	392
21	69.62±.15	148.15± .99	2.46±.11	16.42± .70	+.5731±.0407	124

PHYSICAL DIFFERENCES BETWEEN STUDENTS OF THE VARIOUS COLLEGES

Correlation tables of height and weight were prepared for each age group of each college. The statistical constants derived from these tables of basic data are shown in tables 14 to 23. From these tables it is evident that students in the various colleges differ from each other both in height and in weight. In order to make statistical comparisons of these differences a single index of these measures seemed desirable for each college. This was obtained by computing the mean height, the mean weight, and the mean body build of an equal number of students who were 17, 18, 19, and 20 years of age from each college. The 16 and 21 year old groups were omitted because in some of the colleges the numbers of students in one or both of these age groups are very small and, if they had been included, by the method used, they would have been given an equal weighting with age groups containing many times as many individuals.

TABLE 24

*Comparative Physiques of Men in Certain Colleges**

	COLLEGE	HEIGHT	COLLEGE	WEIGHT	COLLEGE	BODY BUILD †
1.	Princeton	69.28	1. Stanford	144.36	1. College of City of New York	31.04
2.	Yale	69.24	2. Yale	143.52	2. Wisconsin	30.45
3.	Stanford	69.21	3. California	142.58	3. Stanford	30.14
4.	California	69.05	4. Texas	142.36	4. Yale	29.94
5.	Texas	69.01	5. Wisconsin	141.84	5. Minnesota	29.92
6.	Minnesota	68.56	6. Princeton	141.55	6. California	29.90
7.	Cincinnati	68.55	7. Minnesota	140.66	7. Texas	29.89
8.	Cornell	68.48	8. Cornell	139.93	8. Cornell	29.84
9.	Wisconsin	68.25	9. College of City of New York	139.42	9. Cincinnati	29.50
10.	College of City of New York	67.02	10. Cincinnati	138.64	10. Princeton	29.49

* Students of 17, 18, 19 and 20 years of age with equal numbers from each age group.

† These indices of body build have been computed from mean heights and weights. The smaller indices indicate slighter builds.

Height

The range in heights of these individual college groups (Table 24) is from 67.02 inches for students of the College of the City of New York to 69.28 inches for students of Princeton University, a difference of more than 2 inches. Because of the large number of Jewish students attending the College of the City of New York the average height of this group is probably lowered by the racial factor. However, there is a difference of a full inch in height between students of Princeton University and those of the University of Wisconsin. From the tabulation it will be seen that the tallest students are in Princeton, Yale, and Stanford, the three private universities in the group. The state universities are next in order and the municipal institutions toward the bottom of the list. These differences in stature between men of the several colleges are doubtless due to various factors such as racial selection, social and economic conditions, heredity, etc. Acceleration in growth does not appear to be the important factor in producing these differences between colleges, for the students of Princeton and Yale, the tallest two groups, do not attain maximum height until later than the students of Cincinnati, Texas, Minnesota and Wisconsin. Furthermore, at 21 years of age, after growth in height apparently has been completed in all of these groups, the order of the colleges according to height and the differences between the colleges are practically the same as shown in Table 24 for ages 17 to 20. This suggests that the differences in height carry over into the period of adult life and that some factors other than acceleration in growth are responsible for them.

TABLE 25

Heights of College Men and of Draft Recruits (19)

COLLEGE	HEIGHT	
	College Students [1]	Draft [2] Recruits from Same Region
California	69.05	67.67
Texas	69.01	68.40
Minnesota	68.56	68.04
Cornell	68.48	67.45 [3]
Wisconsin	68.25	67.60
College of City of New York	67.02	66.40 [4]

[1] Ages 17 to 20 years inclusive.
[2] 93% from 18 to 31 years of age inclusive.
[3] Agricultural and dairying section of New York State.
[4] New York State, urban areas, densely populated.

In comparison with the first million draft recruits(21) the college students are taller not only for the group as a whole but for individual sections of the country considered separately. In making these comparisons, which are shown in Table 25, only the state universities and the College of the City of New York, both of which tend to draw their students from limited regions, were included. Without exception the college students are taller than the draft recruits from the corresponding areas and the relative heights of college students of various sections of the country are quite similar to the relative heights of draft recruits from similar sections.

Weight

The relative order of colleges by weight of students from 17 to 20 years of age is similar to the order by height (Table 24), although a few changes in position do occur. Princeton, which ranks first in height, ranks sixth in weight; Cincinnati, which ranks seventh in height, ranks tenth in weight; Wisconsin, which ranks ninth in height, ranks fifth in weight. The differences in height and weight which cause these relative changes in rank are in most instances very small. In general, however, the private institutions tend to rank above the state universities in weight as well as in height and the state universities in turn to rank above the municipal institutions. A comparison of the weights of college students with the weights of draft recruits from similar sections of the country cannot be made satisfactorily from the data available on the draft examinations because of the distinct differences in age groupings. In comparing heights, the differences in age are of less consequence because growth in height usually ceases about college age while weight increase continues for a considerable number of years more.

Body Build

The relative body builds of students of the various colleges are shown in Table 24. From this it appears that body build does not follow either height or weight; for the students of the College of the City of New York, who are shortest in stature and next to lightest in weight, have the greatest index of body build. This means that they are a relatively stockier type than any of the others. Princeton students who are tallest in stature and rank sixth in weight are of the most slender body build.

SUMMARY

1. The records of the ages and of the stripped heights and weights of 23,122 college men, approximately equally distributed among ten colleges and universities in different parts of this country, have been tabulated and analyzed.

2. The original purpose of the study was to build tables of average weights, according to age and height, for college students, and to compare these averages with those given in the medico-actuarial tables now used as standards. In addition to this, however, these college students have been compared as to height and weight with certain other male groups of the population; and on the same basis the students of the several colleges and universities have been compared to each other.

3. Only students from 16 to 21 years of age were included in the tabulations because the numbers of individuals at other ages were relatively small.

4. It appears from these studies that college men attain maximum growth in height several years earlier than men in the general population and at each age studied the students are distinctly taller than the men in the groups with which it was possible to compare them; namely, men in citizens military training camps, applicants for life insurance and army recruits.

5. In weight also the college men exceed the men in these other groups, although the relative differences in weight are not so great as the differences in height.

6. The table of graded weights according to age and height of the college men shows certain significant differences from the weights given in the medico-actuarial table but, since these differences are less than the standard deviations of individual cases in the various groups from the means of these groups, either table may be considered as reasonably satisfactory for general use, provided that the possibility of normal individual variations is kept in mind.

7. Distinct differences exist in the heights and the weights of the students of the several colleges studied. In height, the students of the private colleges, Princeton, Yale, and Stanford, exceed those of the state universities and the students of the state universities in turn are taller than the students of the municipal universities studied. In weight, a similar general grouping of institutions is found, although a certain amount of shifting of the positions of individual colleges or universities occurs.

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THE INHERITANCE OF SPORADIC GOITER

BY TAGE KEMP, M. D.

Assistant at the University Institute of General Pathology, Copenhagen

It is well known that abnormalities of the thyroid gland and diseases depending on disturbances of the function of this gland are often hereditary. Of such disturbances sporadic goiter is common and a number of pedigrees demonstrating that sporadic goiter can be inherited have been published.

Endemic goiter is more dependent than sporadic goiter on the environmental causes, and especially important for its appearance is a deficiency of iodine in the food. However, endemic goiter appears also with a special frequency in some families and depends on hereditary factors, as is evident from the studies of Siemens, of v. Pfaundler and of Weitz concerning identical and fraternal twins suffering from this disease and from the pedigrees communicated by K. H. Bauer (1926), and more recently by the very comprehensive family investigations published by Davenport (1932). On the other hand it can hardly be said that we know anything definitely as yet concerning the manner in which endemic goiter depends on hereditary factors.

Furthermore, it is known that exophthalmic goiter often has a high incidence in certain families, and many examples are mentioned in the literature showing cases of simple and exophthalmic goiter in the same family, perhaps with sufficient frequency to suggest that some cases of simple goiter sooner or later develop into exophthalmic goiter (Struma basedowificata). Recently Bing (1932) has published some very well grounded cases of simple and exophthalmic goiter in the same family, where the diagnoses were made not only clinically but by means of microscopical-anatomical examination of the enlarged thyroid gland removed by operation. Again Bing mentions instances where simple and exophthalmic goiter and myxoedema occur in the same family. In this connection he calls attention to recent physiological investigations by Aron (1929) and Loeb and Bassett (1929) showing the dependence of the thyroid gland on the anterior pituitary gland and to the experiments of Krogh, Lindberg and Okkels (1932) which

show that a certain anterior pituitary gland extract injected into guinea pigs is able to produce changes in the thyroid gland and in the metabolism of these animals quite similar to those seen in exophthalmic goiter in human beings.

Thus it must be remembered that the behavior of the thyroid gland is very much dependent on the behavior of other organs in the body as is evident for instance from the functional connection between the thyroid gland and the female sexual organs. A way in which the function of the thyroid gland can indirectly depend on an inherited character is shown in a suggestive manner by Landauer (1932) in his study upon frizzled fowl. He found that the frizzled plumage was brought about by a dominant gene and that the frizzled birds (especially the homozygous ones) showed strikingly increased basal metabolism and heart rate and at the same time an enlargement of the thyroid gland. These symptoms probably were due to the increased loss of heat caused by the defective plumage.

Of the environmental factors on the other hand it is not only the iodine content of the food that is significant for the function of the thyroid gland; it varies, for instance, with the time of year and depends on the temperature of the surroundings.

In sporadic goiter however the thyroid enlargement apparently develops independent of the environment, although it may be that its appearance is often caused by disorders in the iodine metabolism. In some cases of sporadic goiter (according to Bing, in 15-20 per cent of the cases) there can be demonstrated family disposition, but more frequently this is not possible.

A PEDIGREE OF HEREDITARY GOITER

In the following paragraphs a family will be described, which showed several cases of sporadic goiter in three generations. This was a Long Island family of Dutch-English extraction belonging to the artisan class. The groups visited lived in comfortable homes in good neighborhoods. All the members were born on Long Island and had lived there for their whole life-time. Long Island is not a region where endemic goiter is observed; the drinking water is not poor in iodine, and all are living near the seashore and can have plenty of seafood.

The primary evidence concerning the family history and the cases of goiter was collected by the Eugenics Record Office at the Department

of Genetics of the Carnegie Institution of Washington in Cold Spring Harbor, and the author continued and completed the examinations as far as possible. He made a general medical examination of the members of the family who were still alive and with whom it was possible to get into contact. For the other cases it was necessary to depend on the description given by the physician who had treated the patient in question, on the other members of the family, or on the information procured by the Eugenics Record Office.

The pedigree of the family is given in Fig. 1 and the cases of special interest are described below.

The general clinical examination concerned especially the behavior of the thyroid gland and the size, shape, localization, consistence and other qualities of the goiter when present; further stress was laid on an examination for the subjective and objective symptoms, which usually accompany exophthalmic goiter. It was not possible in any case to have the rate of the basal metabolism examined.

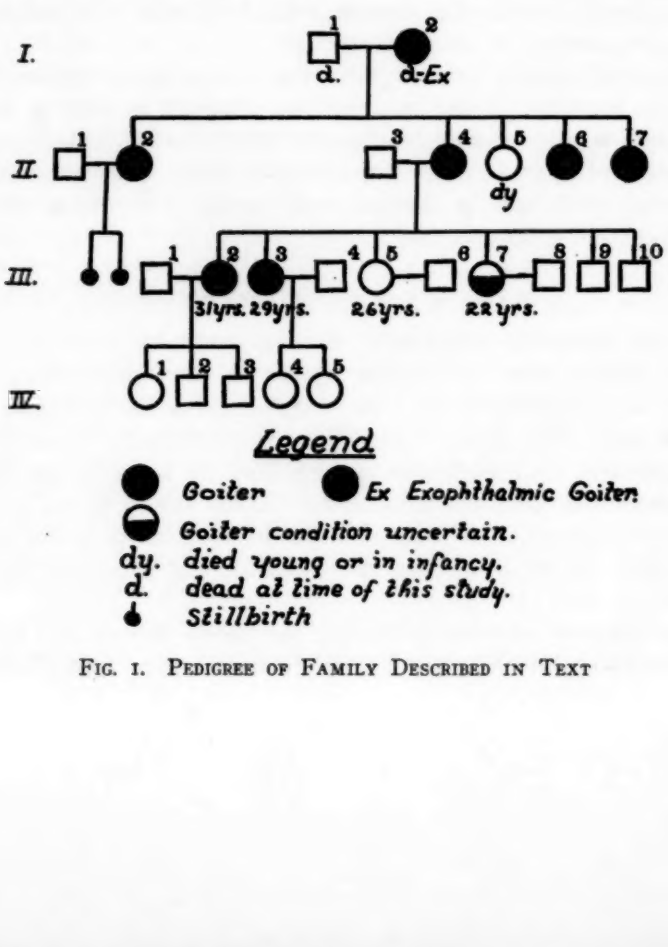

FIG. 1. PEDIGREE OF FAMILY DESCRIBED IN TEXT

I, 1. Married. Died at 72 years age of pneumonia. His relatives agree in stating that he was born on Long Island and lived there during his whole lifetime. He was negative for goiter and there was no history of goiter in his family.

I, 2. Married. Died 13 years ago. Her children report that she was born and grew up on Long Island, but she did not know anything about her ancestry, as she was adopted in her early childhood. When middle-aged, she first noted a thyroid enlargement which at 54 had developed into a typical exophthalmic goiter. Her physician, Dr. Henderson, Huntington, L. I., who had treated her for several years, has stated that she had a marked case of exophthalmic goiter, accompanied by exophthalmus, heart disturbances, nervousness and emaciation.

II, 2. Married. 52 years. In good health during childhood and adolescence. She has had 2 stillborn children at full term, a girl born in 1903, and a boy born in 1909. Menstruation was established at 17 and has always been regular until menopause 5 years ago. At 29 after the birth of her second child she noticed that she had a thyroid enlargement. This has persisted and her physician has diagnosed the case as a simple goiter; exophthalmus, heart disturbances or nervousness have not been observed.

II, 4. Married. 49 years. Always in good health apart from the present disease. Menstruation regular, interrupted by 7 births, until menopause 4 years ago. She first noted a thyroid enlargement at 18, just after marriage. She has in recent years suffered from heart disturbances that have been diagnosed as "weakened" heart. There has never been trouble in swallowing. Appearance healthy, well nourished. Pulse regular, 72. There is a marked thyroid enlargement, diffuse, not pulsating, most developed on the right side. The surface uniform, the consistence elastic. No exophthalmus; Stellwag's, Graefe's or Moebius' symptoms not present. No tremor, skin moist. No nervousness.

II, 5. Unmarried. Died at 25 years age of pneumonia, negative for goiter.

II, 6. Unmarried. 41 years. Healthy in childhood and adolescence. Menstruation established at 16, regular. She noted first a thyroid enlargement at 16, that has persisted since. Some years ago some psychic disturbances became apparent, which gradually developed into a real mental disease. Since that time she has lived in great seclusion together with her older sister (II, 2) and for that reason it has been impossible for the author to examine these two members of the family. Her physician communicated in 1923 the statement that she had a middle-sized simple goiter, that according to information gathered from her relatives still is present, not accompanied, however, with exophthalmus or heart disturbances, and her skin is dry.

II, 7. Unmarried. 37 years. Healthy in childhood and youth, menstruation was established at 17 and has always been regular. Thyroid enlargement first observed at 28; the goiter has increased moderately since then but has never been embarrassing or produced swallowing disturbances. She has always been nervous and considered backward mentally. She is slender and rather thin. There is a medium-sized thyroid enlargement, diffuse but most pronounced in the isthmus and the right lobe, the surface even, no nodular or lumpy masses are seen. No exophthalmus, skin dry, no tremor.

III, 2. Married. 31 years. Healthy in childhood and adolescence. Menstruation was established at 15, regular. Three births, 11, 9 and 7 years ago. The

second child died of diphtheria at 3 years of age, the two other children are still living in good health. Some months ago she first noted a thyroid enlargement; it has never embarrassed her however. She looks healthy, well nourished. There is a moderate enlargement mostly occupying the isthmus and the right lobe. The surface is nodular, consistence soft elastic, not pulsating. Circumference of the neck 36.5 cm. and of the right wrist 16 cm. No marked nervousness. Exophthalmus, Moebius', Stellwag's or Graefe's symptoms are not present. Pulse 72, regular. Hair abundant, skin moist, no tremor.

III, 3. Married. 29 years. Healthy during childhood and adolescence. Menstruation was established at 13, has been regular. She has two healthy children, 6 and 4 years old. Thyroid enlargement was first observed at 16, had perhaps increased moderately since but had never given her any serious trouble. She has always been active, excitable, shy and irritable. She looks healthy, well nourished. There is a marked thyroid enlargement, diffuse but mostly developed on left side, the surface is level, consistence homogeneous. Moebius', Graefe's and Stellwag's symptoms not present. Pulse 68, regular, hair abundant, coarse, skin moist, no tremor, no marked nervousness.

II, 5. Married. 26 years. Negative for goiter.

II, 7. Married. 22 years, the thyroid gland appears very slightly enlarged, especially there is a slight involvement of the isthmial band; it is impossible however at the present to make any final decision whether this enlargement is abnormal or not. No symptoms of exophthalmic goiter are present.

II, 1, II, 3, III, 1, III, 4, III, 6, and III, 8 are all negative for goiter, and nothing is known about goiter in their ancestries.

III, 9 and III, 10 are 17 and 13 years respectively and both negative for goiter.

In this pedigree there occur 7 (8?) cases of sporadic goiter in 3 generations, all the cases are in females and have first appeared when the women were between 16 and 45 years old; in one case there were symptoms of exophthalmic goiter, which probably developed from a primary simple goiter.

Before discussing these observations, however, some other pedigrees from the literature concerning sporadic goiter should be mentioned. As far as known to the author, up to now four such pedigrees have been published that can be considered reliable, where rather detailed information is given about goitrous cases in the pedigree, and where the normal individuals were also examined. These are the pedigrees published by Siemens (1917, 1924) with 9 (10?) cases in 6 generations, by Bluhm (1921) with 15 cases in 4 generations, by Meulengracht (1931) with 7 (8?) cases in 3 generations, and by Bing (1932) with 9 (10?) cases in 2 generations.

WHAT IS THE MANNER OF INHERITANCE?

Siemens concluded from his pedigree that sporadic goiter depends on one dominant gene, which is sex-limited to females, and his suppo-

sition has been generally accepted. All the pedigrees, including the one published here, can be said to be in accordance with the theory started by Siemens. In some cases it happens that a mother who has goitrous daughters is normal herself (for instance in Meulengracht's observation where it was known that a sister of the mother was goitrous). This result could, however, be due to an incomplete expression on penetrancy of the dominant gene; and in several cases men seem to be normal carriers. But there is one decisive objection against Siemens' theory and it is that very frequently all instead of the expected half of the daughters of a goitrous mother suffer from goiter.

If one bears in mind that the goiter very often does not appear before the age of 30 or 40 years or even later, so that the individuals who died in infancy or adolescence cannot certainly be considered as negative for the goiter factor, it can be seen in the pedigrees in Figs. 1, 2, 3, and 4 that very often all the girls in a group of siblings are goitrous if they are still living at 25 years of age. In two cases there are 6 sisters all goitrous (in Meulengracht's and Bing's observations), in one case 5 (in Bluhm's observation Nr. 4, 8, 9, 10, and 11 of third generation), and in two cases 4 (Bluhm's observation Nr. 1, 3, 7, and 9 of second generation and Kemp's observation Nr. 2, 4, 6 and 7 of second generation). In all of these 4 pedigrees there occur 7 mothers carrying the goiter factor who have all together 27 goitrous daughters and none older than 25 years without goiter.

These facts might of course depend on chance, as the number of pedigrees is rather limited, but still it is large enough to make such a possibility very improbable.

It is not true in all cases, however, especially not in Siemens' pedigree, that all the sisters always become goitrous if they reach a sufficient age; but it is the most common thing.

According to the pedigrees it looks as though the sex-limitation is complete; or perhaps there is a sex-linkage. It is not so, however, since Siemens, Bluhm and Meulengracht as well as Bing have observed cases where hereditary sporadic goiter occurs in males; Bing reports that he has found familial disposition with the same frequency in patients of both sexes suffering from sporadic goiter, viz. in 15-20 per cent. The author himself has observed two cases of goiter in males where family disposition could be shown; by the courtesy of the superintendent of the U. S. Veteran Hospital, Northport, L. I., Dr. Brewster, I had the opportunity to examine the cases of goiter occurring among the patients (ca.

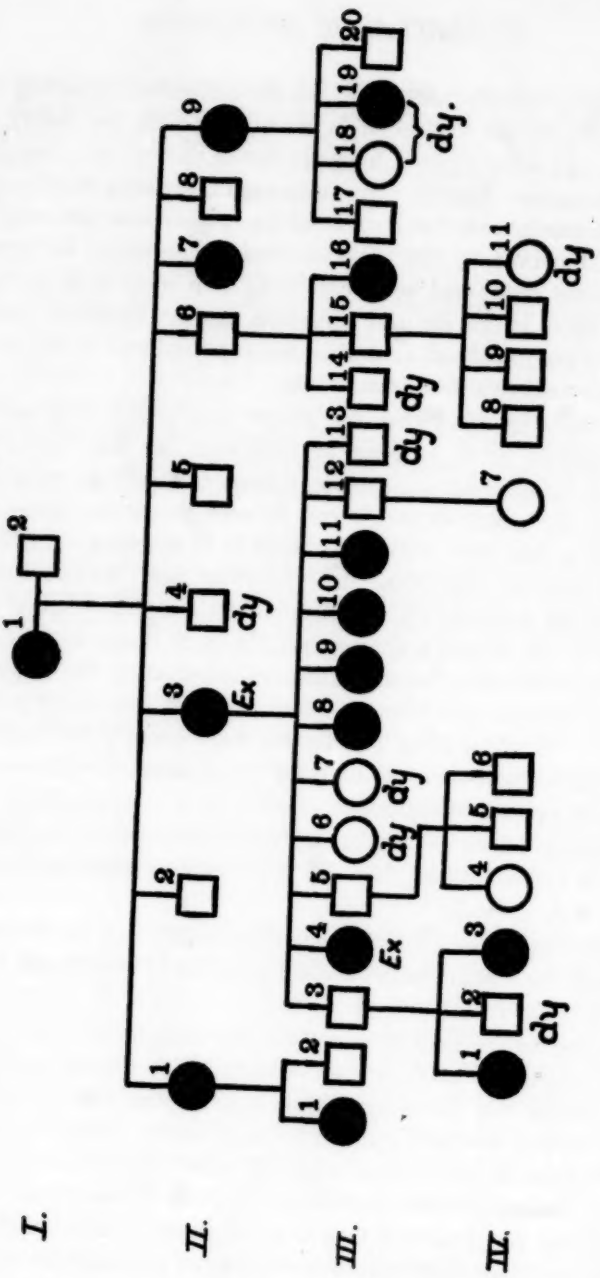

FIG. 2. FAMILY OBSERVED BY AGNES BLUHM (1923)

The pedigree has been redrawn using the same legend as in Fig. 1. In the original pedigree Bluhm indicates the different sizes of goiter the different individuals suffered from; these indications are not copied here.

1500 men, mostly insane); there were observed 5 patients, 2 of whom showed family disposition. They were both suffering from typical sporadic goiter, and each had a mother and a sister suffering from the same disease. Besides these facts very little concerning their families was learned.

There exists no doubt concerning the occurrence of a sex-limiting factor. It is obvious on a casual survey, and Bing found, for instance, that out of 96 cases of sporadic goiter in which family disposition was demonstrated only three or less than a thirtieth part were males.

Recapitulating in accordance with the preceding our knowledge concerning the heredity of sporadic goiter, it can be realized that the disease on the whole is inherited as though dependent on a dominant gene. When the inheritance occurs through the mother she is as a rule goitrous herself; if it come to pass through the father he is generally normal owing to incomplete dominance or penetrancy, as there is a pronounced sex-limitation. Furthermore, it is remarkable that of the children belonging to families where one of the parents carries the factor for sporadic goiter very frequently all the daughters suffer from the disease.

Attempting to ascertain the manner of inheritance, it should first be mentioned, that it appears distinctly from the pedigrees, that it is only possible to accept real heredity and not a pseudo-heredity. The latter might perhaps be supposed a priori because with respect to endemic goiter and endemic cretinism, it is well known that these diseases are in some regions deteriorating from generation to generation especially in the case of maternal inheritance, and in such cases one has to consider paraphoric or plasmatic conveyance (cf. Lenz (1927)).

If the frequent occurrence of goitrous daughters from mothers bearing the factor for sporadic goiter mentioned above should be explained according to the hypothesis that the disease depends on a single

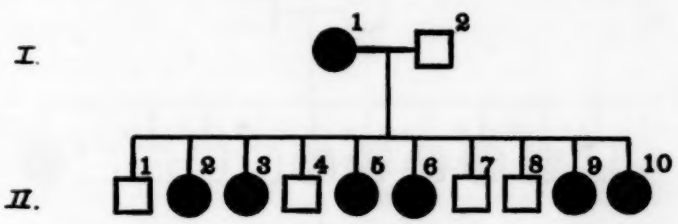

FIG. 3. PART OF PEDIGREE PUBLISHED BY BING (1932)
Redrawn. Legend as in Fig. 1.

dominant gene there are from a genetical point of view several possibilities. It could be supposed that one of the parents was homozygous for the dominant gene. But nothing confirming that view appears from the pedigrees or the details accompanying them. Or it could be supposed that both parents were heterozygous, which would result in 75 per cent goitrous daughters, which would be more in accordance with the facts than 50 per cent. But no evidence corroborating this is found. Theoretically, one could further imagine that daughters bearing the gene should have more vitality than daughters without it but that is very improbable.

Thus on the whole it is very difficult to bring the supposition that sporadic goiter depends on a single dominant gene segregating normally into accord with the facts shown from the pedigrees.

THE NON-DISJUNCTION HYPOTHESIS

It is, however, possible to give an explanation that would correspond with the pedigrees and at the same time agree with circumstances well known in Drosophila; viz, the following:

Hereditary sporadic goiter depends on a dominant gene placed in an X-chromosome and causing not only the development of goiter but also non-disjunction of the two X-chromosomes in the female. Besides this sex-linkage it would be reasonable to suppose that sex-limitation also occurred.

It might then be expected that the chromosome constitution in females in these families aside from the autosomes was Xg X Y, where Xg indicates the X-chromosome holding the gene for goiter. The eggs produced by these women would be XgX and Y which fecundated with spermatozoa from normal males, X or Y, would give the following

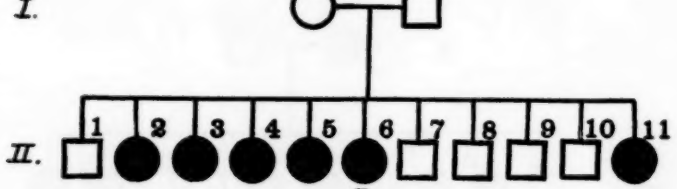

FIG. 4. PART OF PEDIGREE PUBLISHED BY MEULENGRACHT (1931) Redrawn. Legend as in Fig. 1.

zygotes: XgXX, YY, XgXY and XY; the first and the second would probably not be able to develop, the third would result in daughters bearing the gene for goiter and being capable to transmit this gene to all their daughters; the fourth would give normal men without the gene for goiter.

It is now a common finding, however, in Drosophila that show this manner of non-disjunction, that exceptions from the general rule appear in such a way that the non-disjunction of the two X-chromosomes does not occur, and the choromosome-constitution of the eggs will then be Xg and XY or X and XgY. It is evident that the fecundation of these gametes with normal sperms now and then would result in females without the gene g and males carrying this gene. In accordance with this there actually occur now and again in the goitrous families, normal females having normal daughters and males which are conductors or are goitrous themselves.

It is obvious, however, that this explanation of sporadic goiter in human beings is far from established by the pedigrees mentioned in this paper. It is true that it is in accordance with the facts known so far, and is consistent with a method of heredity known to occur in the animal kingdom.

To obtain a solution of the problem it is of course necessary to collect material far more extensively both by following the families already known into the future, and by investigating other goitrous families. In such prospective investigations it would be of decisive significance to have as far as possible all the individuals of the families examined by skilled investigators, preferably by physicians. One ought especially to call attention to eventual occurrence of inbreeding in such families and to the possible existence of several such families in the same isolated locality.

It seems to me, however, that the pedigrees mentioned above should stimulate us to proceed with the investigations. The tendency they show is obvious, and apparently it should be possible to prove definitely the way sporadic goiter is inherited.

On the other hand one must of course realize the considerable variation the several cases of sporadic goiter show as well from a clinical as from a morphological point of view, and likewise that this disease very probably may depend in the different families on genes of quite diversified character. In this connection Brain's (1927) work has to be remembered; he has made a study of goitrous families in semi-endemic

regions, and he concludes that simple goiter may be inherited in some families as a dominant and in others as a recessive factor; one of the genes occurs equally in males and in females and is always associated with hereditary deaf-mutism. This gene seems not to have been found outside of the region studied by Brain.

Finally, the author wishes to acknowledge that it has been possible for him to collect the material published here only through the courtesy and help of Dr. Charles B. Davenport, and further he desires to express appreciation to Dr. N. W. Timoféeff-Ressovsky with whom he has discussed the genetical problems.

SUMMARY

A family with 7 cases of sporadic goiter in three generations is described. Some other pedigrees from the literature concerning sporadic goiter are mentioned.

It is remarkable that of the children belonging to families where one of the parents carries the factor for the disease very frequently all the daughters suffer from it. Thus it is improbable that sporadic goiter depends on a single dominant gene, segregating normally.

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A CLASSIFICATION AND CODE OF OCCUPATIONS[1]

BY RAYMOND PEARL

INTRODUCTION

The classification of occupations used by the Bureau of the Census in tabulating the returns of the Fifteenth Census (1930) has as its ten divisions the following rubrics:

Agriculture
Forestry and fishing
Extraction of minerals
Manufacturing and mechanical industries
Transportation and communication
Trade
Public service (not elsewhere classified)
Professional service
Domestic and personal service
Clerical occupations

All gainfully employed persons are subsumed under these rubrics. A coal mine owner and a coal miner are both counted in the "Extraction of minerals" category. From the point of view of industrial statistics this is a sound and reasonably satisfactory procedure. Both the coal mine owner and the coal miner are connected with the coal mining industry, and get their respective livings out of it.

But, as I [2] pointed out some years ago in discussing the problem of differential fertility, such a classification furnishes something less than a precise and comprehensive picture of the social and economic import of the occupational distribution of the population. Plainly the coal mine owner and the coal miner, to continue our illustration, do not belong in the same category socially, or economically, or psychologically. In-

[1] From the Department of Biology, School of Hygiene and Public Health, Johns Hopkins University.

[2] Pearl, R. Differential fertility. *Quart. Rev. Biol.*, Vol. 2, pp. 102-118, 1927.

come, standard of living, and outlook upon and attitude towards almost every conceivable subject are widely different in the two cases. To group together such diverse kinds of persons is practically to nullify any chance of learning anything, by statistical methods, of the influence of social and economic variables upon such biological variables as mortality, natality, or fertility. The *desideratum* is to put together in the same statistical category persons who will, when so placed, constitute a group as nearly as possible *homogeneous* in respect of social and economic status and attitudes. The complete achievement of this ideal is admittedly impossible, so far as official census statistics are concerned. But it should be, and in fact is, possible to make a nearer approach to it than is done in the official classification.

For this reason, in preparing the paper referred to above, I ventured to rearrange the sub-rubrics of the Census Bureau's classification in order to make it somewhat more in accord with social and economic actualities. The rearrangement at that time had to be a rather rough one, and it was frankly stated to be so. The only attempt then made was to bring together roughly into one group the persons in the upper socio-economic classes, leaving the official main rubrics of the census classification otherwise as they were.

Now the same problem has come to the fore again in our research program in connection with the analysis of the material collected in an extensive investigation of the problem of contraception and fertility.[3] There it became necessary to transfer to punched cards, for mechanical tabulation, the records of the occupations of the husbands of some 30,000 women included in the study. It was felt to be desirable to take the opportunity to give careful consideration to the classification of occupations for purposes of socio-economic research, in connection with the making of a code for the card-punching operations. The result is embodied in the present paper, in the thought that it may be useful to other workers. It still is far from a perfect classification, but at any rate it makes a start towards a definite end, and a basis for further clarification and improvement.[4]

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[3] Cf. Pearl, R. Contraception and Fertility in 2000 Women. HUMAN BIOLOGY, Vol. 4, pp. 363-407, 1932.

[4] Essentially the same objective is sought in the classification of occupations developed by Kiser (HUMAN BIOLOGY, Vol. 5, pp. 256-273, 1933) in his Table 3. He divides occupations into four main groups instead of the three here developed. Furthermore his classification and the present one differ in a number of respects in the assignment of sub-rubrics.

It should be noted, and indeed emphasized, that the present classification of occupation applies *only to males.* To make it apply to females as well would require the inclusion of a number of additional sub-rubrics. These are omitted because our present problem does not require them.

THE PHILOSOPHY OF THE CLASSIFICATION

The ultimate sub-rubrics of the following classification are, in the main, the same as those of the Census Bureau's classification. But here they are arranged under three general headings, as follows:

I. Owners, managers, officials, and professional men.
II. Skilled and semi-professional workers.
III. Laborers—unskilled and semi-skilled.

The underlying idea is to contrast *primarily* two groups of persons, namely those (I) who, on the whole, are situated at or near the top of things in the existing social organization, and those (III) who, by and large, find themselves at or near the bottom in the same social organization. This leaves a third class (II); persons who are, on the whole, neither very near the top nor the bottom, and who, if they are sometimes thought and sometimes think themselves to be worse off than those in class I, are plainly and admittedly better off, on the whole, than those in class III.

The distinction between classes I and III is a real and fundamental one. By and large—that is to say in a statistical sense and with some admitted exceptions—the individuals falling in class I have much higher incomes and standards of living than those in class III; incomes in fact high enough—again with individual exceptions—so that they have definite marginal resources which not only give them a feeling of relative security as regards biological survival, but also make possible education for themselves and their children and indulgence in various luxuries and pleasures. Their social philosophy—again speaking generally—grounds itself upon the belief that human beings differ, one from another, in ability and all other qualities and characteristics, some men being in fact superior to others. Class I individuals further incline to the view that, in general and so far as possible, rewards should be proportioned to abilities of whatever sort. They believe in thrift and its consequences, that is to say that any individual is entitled to have and to hold as much wealth as he is able to acquire, and to use it as he pleases, insofar as the

acquiring and using of it does not *per se* prevent others from doing the same thing if they are able to. As individuals they have a real and tangible stake in the whole social-economic structure, and therefore tend towards individualistic, capitalistic attitudes, and oppose socialistic and communistic attitudes. They pay practically all of the revenue derived from income taxes, and a considerable part of all taxes.

On the other hand, the individuals of class III—and again by and large and in a statistical sense—have low incomes and standards of living; so low, generally speaking, as never to be much above the minimum necessary for biological survival. Sometimes they drop temporarily below this minimum. They have few or no marginal resources individually and are therefore correspondingly restricted in such matters as education, luxuries, and pleasures. Their social philosophy—again with the stated qualifications—tends towards the view that, regardless of any question of differences there may be between human beings, the existing distribution of wealth is fundamentally undesirable, and that a primary function of government should be to redistribute it by some mechanism (taxes, death duties, capital levies, etc.), so that surpluses shall be taken away from the "haves" and given to the "have nots." They do not set great store by thrift and its consequences for two sound reasons. The first of these is that thrift tends *per se* to bring about the sort of existing distribution of wealth that they find unsatisfactory; the second is that experience has taught them that society does not permit them to starve or be otherwise biologically eliminated when they find themselves unable to make their own living. Having no tangible stake in the social-economic structure beyond what inheres in being living human organisms they tend to socialistic and communistic attitudes and are opposed to the capitalistic and individualistic. They pay virtually no direct taxes. The amount of indirect taxes they pay appears never to have been precisely determined, and in any case probably varies widely at different times and in different places. But they are so little sensible of any burden upon them of the cost of government and public improvements that they always vote overwhelmingly in favor of loans for such improvements, on the ground that they will get the benefits and someone else will pay for them.

There is much of reality in the differing circumstances, and much of reason in the differing attitudes of class I and class III. So much so, in point of fact, that experience indicates that in cases where events bring about the transposition of particular individuals from class I to

class III, or from class III to class I, these individuals after the transposition tend to drop the attitudes of the class from which they came and adopt those of the class into which they arrive.

The individuals falling in class II are generally intermediate in their circumstances and attitudes between the other two, some tending more towards one, others more towards the other.

What has been said gives the theoretical picture of the classification here attempted. Practically it can only be approximated in actual fact. The individuals falling statistically into any particular occupational sub-rubric—say for example "Undertakers"—are not all precisely alike either in circumstances or attitudes. The whole enterprise of the classification and subsequent tabulation of occupational data is bound to be a *statistical* one, as distinct from an individualistic one with the unvarying precision of a mathematical relationship. Viewed as a statistical matter I think that there can be no reasonable doubt that classes I, II, and III of the following classification, taken broadly as wholes and as constituted, are definitely and significantly differentiated from each other in the ways indicated above.

Unfortunately some of the larger sub-rubrics are very heterogeneous, from the social and economic viewpoints. For example the "Retail dealers" group, put in class I because the included individuals are proprietors, includes such diverse persons as the owner of the great metropolitan department store and the basement grocery store keeper. Some of these "Retail dealers" in class I undoubtedly have smaller incomes and lower standards of living than some of the individuals in the (broadly) artisan class II. Other sub-rubrics that entail similar difficulties are "Designers, draftsmen, and inventors," "Musicians," "Teachers," "Photographers," and "Social workers." But in all such cases the worker is, after all, in some degree professionally trained, and inevitably has to some extent the attitudes which such training and a socially superior position give. Proceeding towards the other end, similar difficulties present themselves. There is no very sharp or clear-cut distinction between certain of the sub-rubrics in class II and class III. In placing the occupations where they are in the new classification I have used the best judgment of which I was capable on the basis of such knowledge as I have at first-hand or have been able to acquire as to the actual social circumstances and attitudes of persons getting their livings in various ways. I have pondered carefully over the border-line cases, but cannot suppose that everyone will agree with the judgments reached.

As an illustration of the application of the classification the following table is presented. It gives the distribution of employed males in New York State and New York City, as reported in the 1930 census. The state figures include those for the city. The illustration has no special significance. It merely shows how the populations of the largest state and the largest city in the country were distributed in 1930.

CLASS	NEW YORK STATE		NEW YORK CITY	
	Number	Per cent	Number	Per cent
I. Owners, managers, officials and professional men	851,032	20.7	434,560	18.7
II. Skilled and semi-professional workers	2,055,475	50.0	1,249,315	53.7
III. Laborers — unskilled and semi-skilled	1,201,725	29.3	640,724	27.6
Totals	4,108,232	100.0	2,324,599	100.0

No extended comment on these figures is necessary. About half the population falls in the middle, broadly artisan, class II. There are fewer in class I than in class III, even with class I as broadly inclusive as it is.

THE CODE

For the purposes for which the classification has been made it has seemed unnecessary to go beyond the degree of fineness in the separation of sub-rubrics that can be accommodated in a two-digit code for card-punching usage. In coding, however, full use has been made of the 12 possibilities in each column, thus getting opportunity for 144 separate sub-rubrics. In the code numbers B denotes the "blank"-key of the punch and X the X-key.

CLASSIFICATION AND CODE NUMBERS OF OCCUPATIONS

MALES

Code No. *Occupation*

BB No information as to occupation.

I. OWNERS, MANAGERS, OFFICIALS, AND PROFESSIONAL MEN

BX Owners, managers, and officials of log and timber camps, and lumber companies.

Code No.	*Occupation*
Bo	Owners, managers, and officials of mines.
B1	Owners of farms.
B2	Owners, managers, and officials of manufacturing establishments and companies.
B3	Owners, managers, and officials of garages, and of trucking, transfer and cab companies.
B4	Owners, managers, and officials of wholesale and retail establishments, including "retail dealers," and importers and exporters, and insurance companies.
B5	Owners and managers of hotels, restaurants, cafes, and lunchrooms.
B6	Owners, managers, and officials of theaters and other amusement enterprises.
B7	Owners, managers, and officials of laundries, cleaning, dyeing and pressing establishments.
B8	Owners, managers, and officials of real estate companies.
B9	Bankers, brokers, and money lenders.
XB	Builders and building contractors.
XX	Railroad (steam and street) officials and superintendents, and other transportation and communication owners and officials not elsewhere specified.
Xo	Officials in public service (U. S., state, city, and county) including officers of Army, Navy, and Marine Corps.
X1	Actors and showmen.
X2	Architects.
X3	Artists, sculptors, and teachers of art.
X4	Authors, editors, and reporters.
X5	Chemists, assayers, and metallurgists.
X6	Clergymen and other religious workers.
X7	College and university presidents, professors, and other officials.
X8	Dentists.
X9	Designers, draftsmen, and inventors.
oB	Lawyers, judges, and justices.
oX	Musicians and teachers of music.
oo	No occupation (retired persons, capitalists, *rentiers*, etc., *Not unemployed*).
o1	Osteopaths, chiropractors, and other healers.
o2	Photographers.

Code No.	*Occupation*
03	Physicians and surgeons.
04	Teachers (not elsewhere specified).
05	Engineers, technical (civil, mechanical, electrical, etc.).
06	Nurses, trained.
07	Veterinary surgeons.
08	Librarians.
09	Social and welfare workers.
1B	Abstracters, notaries, and justices of peace.
1X	Other occupations falling under Class I, as explained in text.

II. SKILLED AND SEMI-PROFESSIONAL WORKERS

A. Agriculture

10	Farm managers and foremen, gardeners.

B. Forestry and Fishing

11	Fishermen and oystermen.
12	Foresters, forest rangers, and timber cruisers.
13	Foremen, inspectors, scalers, and surveyors in lumbering operations.

C. Extraction of Minerals

14	Mine foremen, overseers, and inspectors.

D. Manufacturing and Mechanical Industries

15	Apprentices in all trades.
16	Bakers.
17	Blacksmiths.
18	Forgemen and hammermen.
19	Boilermakers.
2B	Brick and stone masons and tile layers.
2X	Cabinet makers.
20	Carpenters.
21	Compositors, linotypers, and typesetters.
22	Coopers.
23	Dressmakers.
24	Dyers.
25	Electricians.
26	Electrotypers, stereotypers, and lithographers.
27	Engineers (stationary), cranemen, hoistmen, etc.

Code No.	Occupation
28	Engravers.
29	Filers, grinders, buffers, and polishers.
3B	Firemen (except locomotive and fire department).
3X	Foremen and overseers (manufacturing).
30	Furnace men, smelter men, heaters, puddlers, etc.
31	Glass blowers.
32	Jewelers, watchmakers, goldsmiths, and silversmiths (manufacturing).
33	Loom fixers.
34	Machinists, millwrights, and toolmakers.
35	Mechanics (not otherwise specified).
36	Millers.
37	Milliners.
38	Moulders, founders, and casters.
39	Oilers of machinery.
4B	Painters, glaziers, varnishers, enamelers, etc.
4X	Paper hangers.
40	Pattern and model makers.
41	Piano and organ tuners.
42	Plasterers and cement finishers.
43	Plumbers and gas and steam fitters.
44	Pressmen and plate printers.
45	Rollers and roll hands.
46	Roofers and slaters.
47	Sawyers.
48	Shoemakers and cobblers (not in factory).
49	Stone cutters.
5B	Structural iron workers.
5X	Tailors.
50	Tinsmiths and coppersmiths.
51	Upholsterers.
52	All other skilled and semi-professional workers in manufacturing and mechanical industries.
	E. Transportation and Communication
53	Boatmen, canalmen, and lock keepers.
54	Captains, masters, marine engineers, mates and pilots.
55	Chauffeurs, truck, bus and tractor drivers, draymen and teamsters.

Code No.	*Occupation*
56	Railroad (steam and street) conductors, brakemen, baggagemen, switchmen, flagmen and yardmen; ticket and station agents; foremen and overseers.
57	Railroad (steam and street) engineers, firemen, and motormen.
58	Postmasters, mail carriers, and clerks.
59	Telephone, telegraph, radio operators, and linemen.
6B	Express agents and messengers.
6X	Other skilled and semi-professional workers in transportation and communication.
	F. Trade
60	Advertising agents.
61	"Clerks," decorators, and window dressers in stores.
62	Commercial travellers.
63	Deliverymen.
64	Floorwalkers, buyers, foreman, and overseers in stores.
65	Salesmen (auctioneers, canvassers, demonstrators, sales agents, insurance and real estate agents).
66	Undertakers.
67	Other skilled and semi-professional workers in trade.
	G. Public Service
68	Firemen (fire department).
69	Guards, watchmen, and doorkeepers.
7B	Marshals, sheriffs, detectives, etc.
7X	Policemen.
70	Soldiers, sailors, and marines.
71	Other public servants, not elsewhere specified.
	H. Professional Service
72	Attendants, assistants, and helpers in professional pursuits.
73	Other professional and semi-professional workers, not elsewhere specified.
	I. Domestic and Personal Service
74	Barbers, hairdressers, manicurists, and bootblacks.
75	Boarding and lodging house keepers.
76	Nurses (not trained).
77	Other domestic and personal services, not elsewhere specified.

Code No.	*Occupation*
	J. Clerical Occupations
78	Accountants, auditors, bookkeepers, and cashiers.
79	Agents, collectors, and credit men.
8B	Clerks (except "clerks in stores" and mail clerks).
8X	Stenographers and typists.
80	Other clerical occupations, not elsewhere specified.
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81	Farm laborers.
82	Miners (including all operatives in extraction of minerals).
83	Factory and shop operatives and laborers.
84	Longshoremen, stevedores, sailors, and deckhands.
85	Lumbermen, raftsmen, and woodchoppers.
86	Laborers in garages and stables; on roads and streets; and for truck, transfer, bus and cab companies.
87	Railroad (steam and street) laborers.
88	Laborers in public service.
89	Laborers in connection with professional pursuits.
9B	Elevator tenders.
9X	Janitors and sextons.
90	Porters.
91	Domestic servants.
92	Waiters.
93	Messenger, errand, and office boys.
94	Theater ushers.
95	Cleaners (charwork).
96	Laborers in trade.
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KENELM DIGBY, SEVENTEENTH CENTURY PSYCHOTHERAPIST*

BY WILLIAM M. GAFAFER

In the byways of the history of science there are few subjects that are more curious and more fascinating than the sympathetic cure of wounds. One of the sympathetic cures was the sympathetic powder and intimately associated with it is the name of Sir Kenelm Digby of whom it is said that he was the first to introduce it into England.

Digby, knight, member of the first Council of the Royal Society, writer, traveller, linguist, diplomatist, pirate, philosopher, prisoner, political exile, believer in astrology and alchemy, culinary expert [1] and friend of Ben Jonson, James Howell and Clarendon, was born in 1603,[2]

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* Paper No. 182 from the Department of Biostatistics, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Maryland.

Further details concerning the life of Kenelm Digby may be found in *Private Memoirs of Sir Kenelm Digby, . . . written by Himself, Now First Published from the Original Manuscript*, 8vo, London, 1827; the *D. N. B.*; Wood's *Athenae Oxonienses;* Clarendon's *Life*, 3v., 8vo, Oxford, 1759 (v. 1, pp. 33-34), and the Preface by John Bruce to his edition from the original autograph manuscript of the *Journal of a Voyage into the Mediterranean by Sir Kenelm Digby, A.D. 1628*, 4to, Camden Society [Pub. No. 96], 1868.

See also the *Index-Catalogue of the Library of the Surgeon-General's Office, United States Army*, under **Sympathy** (*Cures by*), and T. J. Pettigrew, *On Superstitions Connected with the History and Practice of Medicine and Surgery*, 8vo, London, 1844 (pp. 157-167).

[1] See his *The Closet Opened, Whereby is Discovered Several Ways for making of Metheglin, Syder, Cherry-Wine, &c. together with Excellent Directions for Cookery, also for Preserving, Conserving, Candying*, 8vo, London, 1677. An octavo edition with an introduction, notes and a glossary by Anne Macdonell appeared in London in 1910.

[2] According to Jonson, John Aubrey, Richard Ferrar and others, the day of birth was June 11. On the same day in 1628 Digby was victorious at Scanderoon, and on the same day in 1665 he died. John Bruce, *loc. cit.*, p. xii, concluded after an examination of one of Digby's manuscripts that the day of birth was July 11. Jonson in *Underwoods* couched his belief in the following:

> *Witness his action done at Scanderoon,*
> *Upon his birth-day, the eleventh of June.*

Aubrey in his *Miscellanies upon Various Subjects* [first issued in 1696], 8vo,

the year his father was knighted by James I and two years before his father was executed for taking a leading part in the Gunpowder Plot. The son was brought up in the lap of Romanism, was exposed to Protestantism for a decade and in 1636 he again embraced his original faith. About 1618 he was sent to Oxford where Thomas Allen (1542-1632) became his pro-guardian. "There was," writes Aubrey,[3] "a great friendship between him and Mr. Thomas Allen; whether he was his scholar I know not. Mr. Allen was one of the learnedest men of this nation in his time, and a great collector of good bookes, which collection Sir Kenelm bought (Mr. Allen enjoyeing the use of them for his life) to give to the Bodlean Library, after Mr. Allen's decease, where they now are." Digby left Oxford after two years and spent the following three on the continent. He was knighted in 1623. And about two years later "much against his mother's etc. consent he maried that celebrated beautie and courtezane, Mrs. Venetia Stanley, whom Richard earle of Dorset kept as his concubine, had children by her, and setled on her an annuity of *500 li.* per annum; which after Sir Kenelm Digby maried was unpayed by the earle; and for which annuity Sir Kenelm sued the earle, after mariage, and recovered it. He would say that a handsome lusty man that was discreet might make a vertuose wife out of a brothel-house. . . . She died suddenly, and hard-hearted woemen would censure him severely." [4]

About a year or two after his marriage Digby introduced to the public his sympathetic cure of wounds by means of the powder of sympathy. This appeared in the form of a book about thirty years later

London, 4th ed., 1857, writes on pages 4 and 5, "Sir Kenelm Digby . . . was born and died on the eleventh of June, and also fought fortunately at Scanderoon the same day. Hear his epitaph composed by Mr. Ferrar, . . .

Under this stone the matchless Digby lies,
Digby the great, the valiant and the wise:
This age's wonder for his noble parts;
Skill'd in six tongues, and learn'd in all the arts.
Born on the day he died, th' eleventh of June,
On which he bravely fought at Scanderoon.
'Tis rare that one and self-same day should be
His day of birth, of death, of victory."

Note: Scanderoon is the present Gulf of Iskanderun, an arm of the Mediterranean, northeast of the island of Cyprus.

[3] *'Brief Lives,' chiefly of Contemporaries, set down by John Aubrey, between the years 1669 and 1696*, edited by A. Clark, 2v., 8vo, Oxford, 1898; v. 1, p. 225.

[4] Clark, *loc. cit.*, v. 1, p. 226.

in 1658. In 1627 "after many discourses in his understanding he [Digby] concluded that it was necessary for him to employ himself on some generous action that might give testimony to the world how his affections [to Venetia] had nothing impaired the nobleness of his mind . . . whereupon he resolved to undertake speedily something that might tend to the King's service, and gain himself honour and experience." [5]

Thus originated the expedition to the Mediterranean, and so at the age of twenty-four another pirate was born. It is sufficient to say here that the expedition was successful and was hailed by the dispirited English public of that unfortunate period with loud acclamation. During the entire voyage, from December 22, 1627, through February 3, 1629, Digby religiously made entries in his day book. To proceed without sampling the book would be unfair to both the reader and the subject. Perhaps the most appropriate entry to choose occurs on "his day of birth, of death, of victory." This was made on June 11, 1629, at Scanderoon, and reads as follows: [6]

The 11. in the forenoone my boate came backe to me, who brought me certaine newes that in the roade were 4 French vessels, whereof one was come in but a day before, and had still a hundred thousand reals of eight abord her; that withall there were 2 English shippes, 2 Venice galliegrosses, and 2 of their galliones. I stood in with the roade as fast as I could, but before, hauing first made a short speech to encourage my men, I sent my sattia with letters to the Venetian Generall and the English Captaines, to acquaint them who I was, contriuing it so that my letters should be deliuered euen as I came within shott. The Venetian Generall treated my men ill, and sent me word he would sinke my shippes if I went not immediately out of the roade. He did his best, and shott att my flagge, but after I had endured 8 shotte from him patiently, and saluted him with gonnes from him [*sic*], I then fell vpon his vessels with all my might. It continued a cruell fight for about 3 houres. It was most part calme, else I had offended him much more. Towardes night the wind freshed; then I prepared to bord the gallioones, and so meaned to stemme the galeazzes, for I could easily gett the wind of them, hauing much maimed their oares, and they being so frighted (as it appeared by their working and the issue) that they lost all their aduantages. Then the Generall sent to me beseeching peace, and acknowledging his error in a verie abiect manner, hauing hoissed his yardes atrippe to be gone out of the roade in case I refused it. Att the English Viceconsuls entreatie (who came abord me) I granted it to him, but somewhat upon hard termes, the principall of which was that he should abandon the French to my discretion. I had taken them all but one, who was runne aground. During our fight they had carried all their goods on shore. Then I sent

[5] Quoted by Bruce, *loc. cit.*, p. xxxi.

[6] Bruce, *loc. cit.*, pp. 38-40.

to take the gunnes and any thing of value out of them, and to fire the vessels, but the Viceconsul representing to me how much our nation might suffer in hauanias (though I had fairely taken them, they beginning with me, not I with them,) I onely tooke away their flagges and some brasse bases for my boates heads, and sent for my men off of them, and the next day rendered them to their owners. . . .

Whiles I stayed here the Venetians quitted to me the signiority of the roade. The weather was extreme hott; the brize comes from the sea duely euerie day about noone, and continueth till sunnesett, which bloweth the clowdes that way, and the land is so high that they can not passe it, so that the hils are euer couered with fogges, which maketh the place exceedingly vnwholesome; and, because the windes can not refine the aire, those cloudes being alwayes permanent engender much corruption and stinkes, which we were annoyed with if att any time (as vsually in the night) any breath came of from the shore. Our men were verie sensible of the badnesse of the aire, and generally all broke out in their bodies to a sharpe itch.

We pass rapidly over Digby's prison sojourn of 1642[7] and period of exile to his election on December 12, 1660, to the "Invisible College." John Austen and George Bate were the others elected on the same day. The Invisible College became the Royal Society when it was granted a Charter of Incorporation by Charles II on July 15, 1662. The second Royal Charter, dated April 22, 1663, named the first Council of twenty-one members. This list of names is of considerable interest and since it has not been published recently we reprint it here. The following persons constituted the first Council of the Royal Society: William Brouncker (Pres.), Robert Moray, Robert Boyle, William Brereton, Kenelm Digby, Gilbert Talbot, Paul Neile, Henry Slingsby, William Petty, Timothy Clarke, John Wilkins (Sec.), George Ent, William Erskyn, Jonathan Goddard, William Balle (Treas.), Matthew Wren, John Evelyn, Thomas Henshaw, Dudley Palmer, Abraham Hill and Henry Oldenburg (Sec.). Besides the twenty-one members of the Council there were ninety-eight original Fellows. Among these were Ashmole, Aubrey, Barrow, Croone, Dryden, Glisson, Graunt, Huyghens, Pell, Wallis and Christopher Wren.[8] It must not be forgotten that with

[7] "Sir Kenelm Digby was several times taken and let go again, at last imprisoned in Winchester House. I can compare him to nothing, but to a great fish that we catch and let go again; but still he will come to the bait; at last therefore we put him into some great pond for store." *The Table Talk of John Selden* [first issued in 1689], edited by S. H. Reynolds, 8vo, Oxford, 1892; pp. 82-83.

[8] In this connection see Thomas Sprat, *The History of the Royal Society of London*, 4to, London, 3rd ed., 1722; Thomas Birch, *The History of the Royal Society of London*, 4v., 4to, London, 1756-57; Thomas Thomson, *History of the Royal Society*, 4to, London, 1812; C. R. Weld, *A History of the Royal Society*, 2v., 8vo, London, 1848; H. B. Wheatley, *The Early History of the Royal Society*

the formation of the Society there came into being, very naturally, considerable opposition to its aims and its ideals. The Fellows were reminded periodically that they were wasting their time writing trivial and absurd papers, and the knowledge possessed by many of them was not always respected. Thus, the mathematician De Morgan as late as 1830, remarked [9] after he was encouraged to look forward to the F. R. S. "Umph! thought I, for I had that day heard of some recent elections the united science of which would not have demonstrated I, 1, nor explained the action of a pump. Truly an elevation to look up at!" A story attributed to Sir John Hill [10] is repeated but not believed by De Morgan [11] and illustrates well the feeling towards the Society in its youth. Hill, so the story goes, reported to the Society that a sailor had broken his leg as a result of falling from the masthead, that tar water (a panacea of the period) and bandages were applied, and in three days the leg was as well as ever. While the Society was gravely weighing the communication a second one came from Sir John exclaiming that he had forgotten to say that the leg was a wooden one. It is not surprising that Wheatley, the antiquary and bibliographer, in a paper which he read before the Sette of Odd Volumes in 1894, dismissed Hill rather impatiently with, "During his reign [President Martin Folkes'] many inappropriate papers were printed in the *Philosophical Transactions*, and thus some justification was given for the flippant and ignorant criticisms of the mountebank Sir John Hill." [12]

(Sette of Odd Volumes, Privately Printed Opuscula, No. 35, limited to 249 copies), 16mo, Hertford, 1905, and *The Record of the Royal Society of London*, 4to, London, 3rd ed., 1912.

See also a delightful paper with pages in facsimile from Sprat and Birch by John F. Fulton, "The Rise of the Experimental Method: Bacon and the Royal Society of London," *Yale J. Biol. & Med.*, 3: 299-320, 1930-31.

[9] Augustus De Morgan, *A Budget of Paradoxes* [first issued in 1872], edited by D. E. Smith, 2v., 8vo, Chicago and London, 2nd ed., 1915; v. 1, p. 26. Pages 21-30 of volume one contain a satirical account of the Royal Society that is rarely, if ever, alluded to.

[10] For biting satire see Hill's *Review of the Works of the Royal Society of London*, 4to, London, 1751. This work had an excellent effect on the quality of subsequent papers by the Fellows. The book is referred to by Thomson, *loc. cit.*, p. 12; by Weld, *loc. cit.*, v. 1, pp. 484-486, and by De Morgan, *loc. cit.*, p. 21. See *The Record*, mentioned above, pp. 41-47, for references to other authors of depreciatory remarks, *e. g.*, Shadwell, Samuel Butler, Addison, Steele, Swift and Pope.

[11] *Loc. cit.*, v. 1, p. 23.

[12] *Loc. cit.*, p. 20.

We return now to Digby's book on the powder of sympathy which was first published as indicated above in 1658. The title of the third English edition of 1660 which we have before us reads as follows, *A Late Discourse Made in a Solemne Assembly of Nobles and Learned Men at Montpellier in France, Touching the Cure of Wounds by the Powder of Sympathy; With Instructions how to make the said Powder; whereby many other Secrets of Nature are unfolded.*[13] The first edition appeared in French, in Paris, 1658; other French editions were published in 1669 (Paris), 1673 (Rouen), 1681 (Paris), and 1894 (Paris, reprint of the 1681 edition). The first and second English editions appeared in London in 1658, and the third and fourth, also in London, in 1660 and 1664, respectively. A Dutch edition was published in Haarlem in 1661. The third German edition appeared in Frankfurt in 1664, and the seventh in Ratzeburg in 1718. In London, 1669, the *Discourse* was printed with a separate title-page in Digby's *Of Bodies, and of Mans Soul, to Discover the Immortality of Reasonable Souls; With two Discourses: Of the Powder of Sympathy, and Of the Vegetation of Plants.* This book is a quarto with the *Discourse* appearing on pages 145-205 in the second pagination.

The title-page of the third edition of the *Discourse* is reproduced and appears as figure 1.

In the early pages of the *Discourse* Digby before an assembly of nobles and learned men in Montpellier reminds his listeners that he would be very sorry if they should doubt the efficacy of the powder of sympathy and proceeds to describe an instance in which the powder effected a cure. The subject of this cure was none other than James Howell, the author of the fascinating and at one time popular *Familiar Letters.*[14]

[13] See reproduced title page (figure 1). A description of the book follows: 12mo. A-G^{12}. [10] + 152 + [6] pp. 28 lines + pagination line and signature and catchword line, 11.3 (12.3) x 5.7 cm. Page size, 14.0 x 8.3 cm.

A1^{a} title; A1^{b} blank; A2^{a}-A3^{a} dedication to John Digbye [the author's son] by R. White; A3^{b} blank; A4 "An Extract of the Royall priviledge in France for printing the said Discourse" 21 Dec. 1657; A5 "An Information to the Knowing Reader" by R. White; A6^{a} (p. 1)-G9^{b} (p. 152) text of the *Discourse*; G10^{a}-G11^{b} "A Table of the most excellent things delivered in this Discourse"; G12^{a} catalogue of books sold by Davi[e]s; G12^{b} advertisement of "Lozanges . . . for the cure of Consumptions, Coughs, Catharrs, Astma's, Hoarseness, and all other diseases incident to the Lungs, and a soveraign Antidote against the Plague, and all other contagious diseases, and obstructions of the Stomach . . ."

[14] James Howell, *Epistolae Ho-Elianae; Familiar Letters, Domestick and Foreign,* 8vo, London, 8th ed., 1713. Agnes Repplier's well-edited and typographically excellent reprint appeared in two volumes, octavo, in Boston in 1907.

A LATE
DISCOURSE
Made in a Solemne Aſſembly of Nobles and Learned Men at *Montpellier* in *France*,

By Sr. *Kenelme Digby*, Knight, &c

Touching the Cure of WOUNDS by the *Powder of Smpathy*; With Inſtructions how to make the ſaid Powder; whereby many other Secrets of Nature are unfolded.

Fœlix qui potuit Rerum *cognoſcere* cauſas.

Rendered faithfully out of French into Engliſh
By *R. White*, *Gent.*

The third Edition corrected and augmented, with the addition of an Index.

LONDON, Printed for *R. Lowndes* at the *white Lion*, and T. *Davies* at the *Bible* in S. *Pauls* Church-yard, over againſt the little North-Door, 1660.

FIG. 1. TITLE-PAGE OF A LATE DISCOURSE
(The Original measures 13.0x6.8 cm.)

Howell was an enthusiastic Royalist and was for this reason, so he himself records, imprisoned in the Fleet (1643-1651), and there he chiefly wrote the letters to imaginary correspondents. For quotation we have selected pages 6-14 of the *Discourse* where Digby deals with Howell's cure, relates how he, Digby, obtained knowledge of the powder and explains how that knowledge became subsequently "so divulged that now there is scarce any Country-Barber but knows it." The quotation follows:

Mr. *James Howel*, (well known in *France*, by his Writings, and particularly by his *Dendrologia*, translated into French by *Monsieur Baudoin*) coming by chance as two of his best friends were fighting in Duel, he did his endeavour to part them, and putting himself between them, seized with his left hand upon the hilt of the sword of one of the Combatants, while with his right hand he laid hold of the blade of the other: they being transported with fury one against the other, strugled to rid themselves of the hindrance their friend made that they should not kill one another; and one of them roughly drawing the blade of his sword, cuts to the very bone the nerves, and muscles, and tendons of Mr. *Howels* hand; and then the other disingaging his hilts, gave a crosse blow on his adversaries head, which glanced towards his friend, who heaving up his sore hand to save the blow, he was wounded on the back of his hand, as he had been before within. It seems some strange Constellation reigned then against him, that he should lose so much blood by parting two such dear friends, who had they been themselves, would have hazarded both their lives to have preserved his: but this unvoluntary effusion of bloud by them, prevented that which they should have drawn one from the other: For they seeing Mr. *Howels* face besmeared with blood, by heaving up his wounded hand, they both ran to embrace him; and having searched his hurts, they bound up his hand with one of his garters, to close the veines which were cut, and bled abundantly. They brought him home, and sent for a Surgeon. But this being heard at Court, the King sent one of his own Surgeons, for his Majesty much affected the said Mr. *Howel*.

It was my chance to be lodged hard by him; and four or five dayes after, as I was making my self ready, he came to my House, and prayed me to view his wounds, for I understand, said he, that you have extraordinary remedies upon such occasions, and my Surgeons apprehend some fear, that it may grow to a Gangrene, and so the hand must be cut off. In effect, his countenance discovered that he was in much pain, which he said was unsupportable, in regard of the extream inflammation: I told him that I would willingly serve him, but if haply he knew the manner how I would cure him, without touching or seeing him, it may be he would not expose himself to my manner of curing, because he would think it peradventure either ineffectual, or superstitious: he replied, That the wonderful things which many have related unto me, of your way of curing, makes me nothing doubt at all of its efficacy; and all that I have to say unto you, is comprehended in the *Spanish* Proverb, *Hagase el milagro, y hagalo Mahoma*, Let the miracle be done though Mahomet do it.

I asked him then for anything that had the blood upon it, so he presently sent for his Garter, wherewith his hand was first bound: and having called for a Bason of water, as if I would wash my hands; I took a handfull of Powder of Vitriol,[13] which I had in my study, and presently dissolved it. As soon as the bloody garter was brought me, I put it within the Bason, observing in the interim what Mr. *Howel* did, who stood talking with a Gentleman in a corner of my Chamber, not regarding at all what I was doing: but he started suddenly, as if he had found some strange alteration in himself; I asked him what he ailed? I know not what ailes me, but I find that I feel no more pain, methinks that a pleasing kind of freshnesse, as it were a wet cold Napkin did spread over my hand, which hath taken away the inflamation that tormented me before; I replyed, since that you feel already so good an effect of my medicament, I advise you to cast away all your playsters, onely keep the wound clean, and in a moderate temper twixt heat and cold. This was presently reported to the Duke of *Buckingham*, and a little after to the King, who were both very curious to know the issue of the businesse, which was, that after dinner I took the garter out of the water, and put it to dry before a great fire; it was scarce dry, but Mr. *Howels* servant came running, and told me, that his Master felt as much burning as ever he had done, if not more, for the heat was such, as if his hand were twixt coales of fire: I answered, that although that had happened at present, yet he should find ease in a short time; for I knew the reason of this new accident, and I would provide accordingly, for his Master should be free from that inflammation, it may be, before he could possibly return unto him: but in case he found no ease, I wished him to come presently back again, otherwise, he might forbear coming. Thereupon he went, and at the instant I did put again the garter into the water; thereupon he found his Master without any pain at all. To be brief, there was no sense of pain afterward; but within five or six dayes the wounds were cicatrized, and entirely healed. King *James* required a punctuall information of what had passed touching this cure: and after it was done and perfected, his Majesty would needs know of me how it was done, having drolled with me first (which he could do with a very good grace) about a Magician and a Sorcerer; I answered, That I should be always ready to performe what his Majesty should command; but I most humbly desired him, before I should passe further, to tell him what the Author, of whom I had the Secret, said to the great Duke of *Tuscany*, upon the like occasion. It was a religious *Carmelite*, that came from the *Indies* and *Persia* to *Florence*, he had also been at *China*, who having done many marvellous cures with his powder, after his arrivall to *Tuscany*, the Duke said he would be very glad to learn it of him: It was the father of the Great Duke who governs now. The *Carmelite* answered him, That it was a secret which he had learnt in the oriental parts, and he thought there was not any who knew it in *Europe* but himself, and that it deserved not to be divulged, which could not be done, if his Highness would meddle with the practise of it, because he was not likely to do it with his own hands, but must trust a Surgeon, or some other

[13] "The sympathetic powder . . . consisted, it is said, of nothing more than green vitriol, first dissolved in water and afterward recrystallized or calcined in the sun." F. H. Garrison, *An Introduction to the History of Medicine*, 8vo, Philadelphia and London, 2nd ed., 1917; p. 279.

servant, so that in a short time divers others would come to know it as well as himself. But a few moneths after I had opportunity to do an important courtesie to the said Fryer, which induced him to discover unto me his secret, and the same year he returned to *Persia*; insomuch, that now there is no other knows this secret in Europe but my self: The King replied, That he needed not apprehend any fear that he would discover, for he would not trust anybody in the World to make experience of his secret, but he would do it with his own hands, therefore he would have some of the Powder; which I delivered, instructing him in all the circumstances. Whereupon his Majesty made sundry proofs, whence he received singular satisfaction.

In the interim, Doctor *Mayerne*, his first Physitian watched to discover what was done by this secret, and at last he came to know that the King made use of Vitriol. Afterwards he accosted me, saying, he durst not demand of me my secret, because I made some difficulty to discover it to the King himself. But having learnt with what matter it was to be done, he hoped that I would communicate unto him all the circumstances how it is to be used; I answered him, That if he had asked me before, I would have frankly told him all, for in his hands there was no feare that such a secret should be prostituted, and so I told him all. A little after the Doctor went to *France*, to see some fair Territories that he had purchased near *Geneva*, which was the Barony of *Aubonne*. In this voyage he went to see the Duke of *Mayerne*, who had been a long time his friend and protector, and he taught him this secret, whereof the Duke made many Experiments, which if any other but a Prince had done, it may be they had passed for effects of Magick and Enchantments.

After the Dukes death, who was killed at the siege of *Montauban*, his Surgeon who waited upon him in doing cures, sold this secret to divers Persons of Quality, who gave him considerable summes for it, so that he became very rich thereby. The thing being fallen thus into many hands, remained not long in terms of a Secret, but by degrees it came to be so divulged, that now there is scarce any Country-Barber but knows it.

It is curious that the garrulous Howell never refers to his cure by the powder of sympathy in his *Familiar Letters*. He speaks of the powder as healing "at a distance without *topical* applications to the place affected," [16] and in a letter dated November 25, 1629, he congratulates Digby on his successful Mediterranean voyage.[17]

De Morgan [18] doubts Digby's authorship of the *Discourse*, and recalls that Birch in his *History of the Royal Society* makes no record of Digby's introduction of the powder to the Society. Digby's name in connection with the powder, however, is mentioned by Sprat [19] when he quotes Vernatti thus, ". . . that much renowned sympathetical Powder of Sir *Kenelm Digby*."

[16] *Loc. cit.*, p. 507.
[17] *Ibid.*, p. 210.
[18] *Loc. cit.*, v. 1, p. 108.
[19] *Loc. cit.*, p. 165.

NOTES

ON SOME QUANTITATIVE EVIDENCE OF THE EFFECT OF THYROID DISORDER UPON THE BIRTH-RATE

This study was conducted to discover whether any significant relation exists between thyroid disorder and the birth-rate.

An abundance of clinical material has indicated the causal relation of certain endocrine disorders to female sterility. Rowe,[1] in a study of over 1,000 cases of sterility made under the Evans Memorial, found that endocrine disorders were frequent. He found the percentage of sterile marriages highest (35.3) in those showing ovarian disease, next (31.2) in the group showing thyroid disorders, and but slightly lower (28.8) in the women with pituitary disorder. In the non-endocrine group, infertility was definitely less frequent than in that showing endocrine disorders. Meaker[2] gives endocrine disorders an important place in the complexity of causal factors in sterility. Lawrence,[3] also at the Evans Memorial, found in 50 consecutive cases, 54 per cent of the women had definite pelvic hypoplasia. "Results of the study show high incidence of disturbed endocrine function associated with pelvic hypoplasia . . . ."[4] Similar material has been contributed by many other clinicians.[5] Dickinson,[6] however, did not find evidence that endocrine therapy reduced sterility.

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[1] Allan Winter Rowe. Endocrine studies—The influence of endocrines in sterility. *J. A. M. A.*, 95: 1219-1221. Oct. 25, 1930.

[2] Samuel R. Meaker. Constitutional factors in the causation of sterility. *J. A. M. A.*, 92: 1493-1494. May 4, 1929.

[3] C. H. Lawrence, Jr. Menstrual disorders in adolescent girls. Their significance and treatment. *J. A. M. A.*, 95: 1148-1151. Oct. 18, 1930.

[4] *Ibid.*, p. 1150.

[5] Adolphe Jacoby, M. D. Endocrine aspect of female sterility. *Med. Rec.*, 101: 239-41. Feb. 11, 1922.

Wm. H. Cary and Robert T. Dickinson. Sterility and Conception Gynecological and Obstetrical Monographs. Sum. Sup. 1928, pp. 1-11, N. A., Appleton.

Donald Macomber. Ovarian deficiency as a cause of sterility. *Amer. J. of Obst. & Gynec.*, 19: 739-747. June, 1930.

Samuel R. Meaker. A working classification of the causes of sterility. *J. A.*

In order to make a quantitative test of the suggested relation between endocrine disorder and the birth-rate, as indicated by these clinical reports, it was decided to correlate the rates for simple goitre in the states of the Birth Registration area [7] of the United States, and an index of fecundity for the Birth Registration area of the United States as of 1920. Simple goitre was used because it is the only nation-wide index of endocrine disorder on record. This evidence consists of the physical examination of the second million drafted men of the U. S. Army of 1918.[8] While the incidence of goitre is higher in women than in men, presumably the ratio is fairly constant.

The goitre data are for 1918 while the birth statistics are for 1920. In order to get an index of birth-rate it was necessary to derive a figure which we have called an index of fecundity. This was done by taking the ratio of the number of legitimate children born to mothers, 25-34 years of age, to the number of married women, 25-34 years of age. Since the requisite marital statistics for 1918 were not available those for the nearest year, 1920, were chosen. Probably the change in the incidence of goitre in the two years would not be marked.

Furthermore, the lower limit of 25 years of age was chosen in order to eliminate the possibility of the interference of birth control methods upon the birth-rate. That the use of contraceptives definitely tended to reduce births for married women under 25 years of age has been shown by Ogburn for the 1920 census.[9] Thirty-five years of age is arbitrarily

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M. A., 90: 111-114. Jan. 14, 1928.

Emil Novak. Recent advances in the physiology of menstruation. *J. A. M. A.*, 94: 833-839. March 22, 1930.

Oscar Riddle. Some interrelation of sexuality, reproduction and internal secretion. *J. A. M. A.*, 92: 943-950. March 23, 1929.

I. C. Rubin. Ovarian hypofunction, habitually delayed and scanty menstruation in relation to sterility and lowered fertility. *Amer. J. Obst. & Gynec.*, 18: No. 5, Nov. 1929.

[6] Robert L. Dickinson and Wm. H. Cary. Sterility, analysis of cures and failures. *J. A. M. A.*, 88: 1. Jan. 1, 1927.

A. S. Parkes and J. C. Drummond. Relation between fatness and sterility. *Brit. J. Exp. Path.*, 9: 63-9. April, 1928.

[7] "Birth Registration Area composes 59.5 per cent of the total population of the U. S." U. S. Birth Statistics, 1920, Sixth Annual Report. Introd.

[8] Albert G. Love and Chas. B. Davenport. Defects Found in Drafted Men. U. S. Govt. Printing Office, *Washington*, 1920.

[9] Ernest Rutherford Groves and William Fielding Ogburn. American Marriage and Family Relationships, p. 269.

TABLE 1

Rank Correlation of Simple Goitre Ratio with the Index of Fecundity

STATES OF THE BIRTH REGISTRATION AREA, 1920	GRAND TOTAL FOR SIMPLE GOITRE WITH NO. CASES *	RATIO PER 1,000 MEN *	INDEX OF FECUNDITY †	RANK GOITRE *	RANK RATIO OF BIRTHS †
Oregon	421	26.31	.134	1	22
Washington	832	23.40	.141	2	20
Utah	185	15.72	.234	3	1
Wisconsin	886	14.02	.108	4	23
Michigan	1,131	11.43	.1790824	5	12
Minnesota	578	8.04	.200	6	6
Indiana	464	6.49	.156	7	17
Ohio	798	5.59	.153	8	18
California	359	4.45	.145	9	19
Pennsylvania	829	4.10	.193	10	8
Virginia	188	3.38	.203081	11	5
Nebraska	63	2.14	.176	12	14
Vermont	18	2.14	.190	13	9
N. Carolina	100	1.81	.229	14	2
Kentucky	90	1.41	.181	15	11
Dist. Columbia	16	1.39	.135	16	21
Kansas	48	1.25	.163	17	16
New York	308	1.19	.1790822	18	13
Maryland	35	.94	.174	19	15
S. Carolina	37	.94	.188	20	10
Connecticut	32	.89	.20328	21	4
New Hampshire	6	.70	.199	22	7
Massachusetts	29	.32	.214	23	3
				N 23	

* Love and Davenport, op. cit., p. 111.

† Ratio of Births (Birth Statistics of Birth Registration Area of the U. S.) 1920.

established as the upper limit because it gives a good sample of the child-bearing period.

The data for the birth records and the marital statistics were those published by the U. S. Bureau of the Census, 1920.[10]

[10] Department of Commerce, Bureau of the Census. 14th Census of the U. S., 1920, Vol. 2, p. 410 ff. Also Birth Statistics of the Birth Registration Area of the U. S., 1920. Sixth Annual Report, p. 168-192.

The rank method of correlation was used to discover the effect of thyroid disorder upon the birth-rate. This correlation gave

$$\rho = -.38 \text{ or } r_{12}{}^{11} = -.40 \pm .11.$$

This coefficient while low is significant and clearly indicates the probable effect of thyroid disorder on the reduction of the birth-rate.

L. S. Cressman and Edna C. Spenker.

University of Oregon.

[11] 1 = ratio of thyroid disorder per 1,000 men, and 2 = index of fecundity or ratio of births to married mothers between 25-34 to number of married women 25-34 years of age.

RECENT LITERATURE

USEFUL IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Raymond Pearl, Department of Biology, School of Hygiene and Public Health, 1901 East Madison Street, Baltimore, Maryland, U. S. A.

I. EVOLUTION AND GENETICS

1. *Evolution—General Principles*

Fox, Leon A. Teleological Factors in Evolution. Function Determines Structure. A thesis presented to the Faculty of the American University Graduate School in partial fulfillment of the requirement for the degree Doctor of Philosophy, Washington, D. C. 1932. *Baltimore* (Waverly Press), 1933. Pp. ix + 71. 6 × 9 inches. [Bibliography of 70 titles].

Just, E. E. Cortical cytoplasm and evolution. *American Naturalist*, Vol. 67, pp. 20-29, 1933.

Romer, Alfred S. Vertebrate Paleontology. *Chicago* (University of Chicago Press), 1933. Pp. vii + 491. 6¾ × 9¾ inches. $5.00. [Bibliography of 314 titles].

2. *Human Evolution*

Gregory, William K. From fish to man. The natural history of man. *Natural History*, Vol. 32, pp. (of reprint) 4, July-August, 1932.

Gregory, William K. The new anthropogeny: twenty-five stages of vertebrate evolution, from silurian chordate to man. *Science*, Vol. 77, pp. 29-40, 1933.

Power, Francis W., S.J. Chimpanzee Buddy: What of it? *America*, Vol. 49, pp. 9-11, 1933.

Schauinsland, Hugo H. The Great Enigma. A New View on the Outlook of Life. Translated from the German by Walter H. Schauinsland. *New York* (E. P. Dutton and Co.), 1933. Pp. 93. 5¼ × 7½ inches. $1.25. [Bibliography of 31 titles].

3. *Prehistory and Archeology*

Colton, Harold S. Pueblo II in the San Francisco Mountains, Arizona. *Museum of Northern Arizona, Bulletin* 4, pp. 1-14, 1933. [Bibliography of 26 titles].

Colton, Harold S. Wupatki, the Tall House. *Museum Notes (Museum of Northern Arizona, Flagstaff)*, Vol. 5, pp. 61-64, 1933. 10 cents. [Bibliography of 6 titles].

HARGRAVE, LYNDON L. Pueblo II house of the San Francisco Mountains, Arizona. *Museum of Northern Arizona, Bulletin* 4, pp. 15-75, 1933. [Bibliography of 28 titles].

HARRINGTON, MARK R. Gypsum Cave, Nevada. Report of the Second Sessions Expedition. *Southwest Museum Papers* No. 8. *Los Angeles* (Southwest Museum), 1933. Pp. ix + 197. 7 × 10⅜ inches. $2.50 (paper).

4. *Genetics—General Principles*

CREW, F. A. E. Sex Determination. *London* (Methuen and Co.), 1933. Pp. ix + 138. 4¼ × 6¾ inches. 3s. 6d. net. [Bibliography of 12 pages].

CREW, F. A. E., and P. CH. KOLLER. The sex incidence of chiasma frequency and genetical crossing-over in the mouse. *Journal of Genetics*, Vol. 26, pp. 350-383, 1932. [Bibliography of 40 titles].

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CURTIS, M. R., W. F. DUNNING, and F. D. BULLOCK. Genetic factors in relation to the etiology of malignant tumors. *American Journal of Cancer*, Vol. 17, pp. 894-923, 1933. [Bibliography of 11 titles].

CURTIS, M. R., W. F. DUNNING, and F. D. BULLOCK. Is malignancy due to a process analogous to somatic mutation? *Science*, Vol. 77, pp. 175-176, 1933.

JENNINGS, H. S., DANIEL RAFFEL, RUTH S. LYNCH, and T. M. SONNEBORN. The diverse biotypes produced by conjugation within a clone of *Paramecium aurelia*. *Journal of Experimental Zoology*, Vol. 62, pp. 363-408, 1932. [Bibliography of 13 titles].

KREDIET, G. Kastration intersexueller Säugetiere. *Acta Veterinaria Neerlandica*, Tome I, Fascicule 1. *Utrecht* (Maatschappij voor Diergeneeskunde, J. van Boekhoven), 1933. Pp. 120. 6¼ × 9⅝ inches. 5.50 guilders (paper).

RAFFEL, DANIEL. Inherited variation arising during vegetative reproduction in *Paramecium aurelia*. *Biological Bulletin*, Vol. 62, pp. 244-257, 1932. [Bibliography of 9 titles].

SONNEBORN, T. M. Experimental production of chains and its genetic consequences in the ciliate protozoan, *Colpidium campylum* (Stokes). *Biological Bulletin*, Vol. 63, pp. 187-211, 1932. [Bibliography of 7 titles].

SONNEBORN, T. M., and RUTH S. LYNCH. Racial differences in the early physiological effects of conjugation in *Paramecium aurelia*. *Biological Bulletin*, Vol. 62, pp. 258-293, 1932. [Bibliography of 14 titles].

5. *Human Heredity*

COCKAYNE, E. A. Inherited Abnormalities of the Skin and its Appendages. *New York* (Oxford University Press), 1933. Pp. x + 394. 5½ × 8⅝ inches. $8.00.

CURTIUS, FRIEDRICH. Multiple Sklerose und Erbanlage. *Leipzig* (Georg Thieme), 1933. Pp. 215. 6¾ × 10 inches. 18 marks (paper); 20 marks (cloth). [Bibliography of 11 pages].

FISCHER, EUGEN. Genetik und Stammesgeschichte der menschlichen Wirbelsäule. *Biologischen Zentralblatt*, Bd. 53, pp. 203-220, 1933. [Bibliography of 15 titles].

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